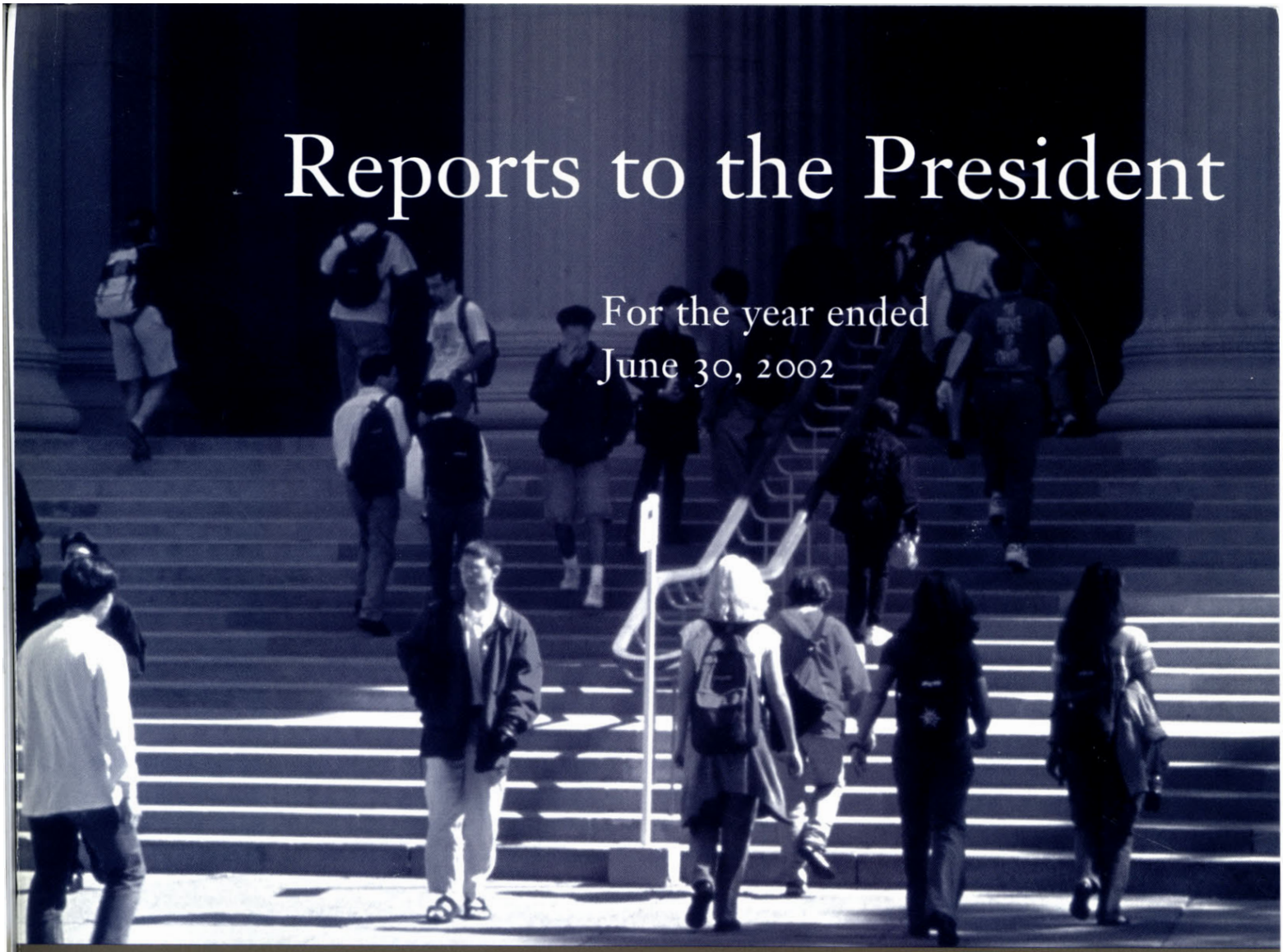

Reports to the President

For the year ended
June 30, 2002

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Reports to the President

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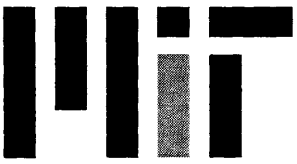

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2001–2002

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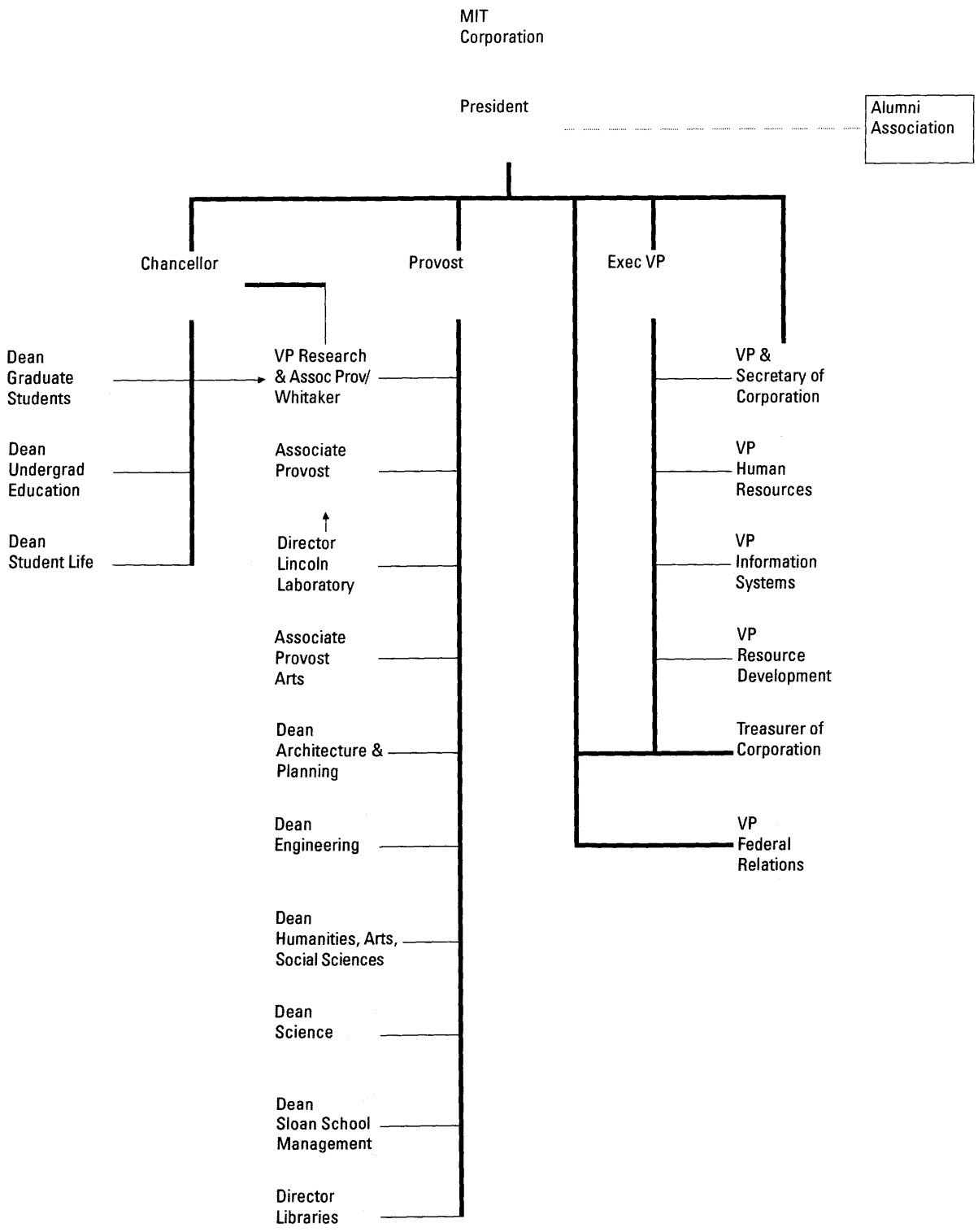

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Response and Responsibility

Balancing Security and Openness in Research and Education

> *The scale and nature of the ongoing revolution in science and technology, and what it implies for the quality of human capital in the 21st century, pose critical national security challenges for the United States. Second only to a weapon of mass destruction detonating in an American city, we can think of nothing more dangerous than a failure to manage properly science, technology, and education for the common good over the next quarter century.*
>
> *U.S. Commission on National Security in the 21st Century*
> *March 15, 2001*

Openness and Security

The ability of our nation to remain secure in the face of both traditional military threats and international terrorism while maintaining the excellence and pace of American science and technology requires a delicate balance. It depends first and foremost on effective dialogue and joint problem solving by those responsible for maintaining our security and those who lead our scientific, engineering, and higher education communities.

Our immediate impulse when threatened is to wall ourselves off and to regulate the release of information of potential use to our enemies. This is understandable, and frequently justified, but in today's complicated world, the security issues raised regarding research and education do not lend themselves to simple responses—especially when long-term consequences are considered. Why?

The future health, economic strength, and quality of life in America, and indeed the world, depend on the continued rapid advance of science and technology, and on the education of scientists and engineers at the most advanced levels. The rapid progress of science and technology, and the advanced education of scientists and engineers, in turn, depends critically on openness of process, openness of publication, and openness of participation within our institutions and across national boundaries.

Historically, our nation and world have faced many challenges to peace and security. Now we face a constant threat of determined terrorists. Their immediate objectives are to kill large numbers of people, or to cause terror, panic, or disruptions of our lives and economy.

As we respond to the reality of terrorism, we must not unintentionally disable the quality and rapid evolution of American science and technology, or of advanced education, by closing their various boundaries. For if we did, the irony is that over time this would achieve in substantial measure the objectives of those who disdain our society and would do us harm by disrupting our economy and quality of life.

Americans are learning that the balance between protection of our lives and of our liberties is as difficult to strike as it is essential that we do so. I believe that it is equally imperative that we strike the right balance between security and the openness of our scientific research and education. But I conclude that we must rely very heavily on maintaining that openness.

In the year since the murderous attacks in New York, Washington, and Pennsylvania, the experience of MIT and other leading research-intensive universities has been primarily one of calm and reasoned interaction and consultation with the Federal government on such matters as the admission of international students and scholars, the openness of scientific research, and the control of dangerous chemical and biological agents.

However, the discussion of these issues and the establishment of a regulatory environment associated with homeland security are far from over. It therefore seems timely to address some of the fundamental issues and long-term consequences of our decisions.

Before doing so, let me make clear that, although it is not the topic of this essay, MIT and our sister institutions take very seriously our responsibility to serve our nation by applying our talents and capabilities to the protection of human life and infrastructure in our homeland and throughout the world. (See, for example, our website on MIT research and education on homeland and global security: http://web.mit.edu/homeland/index.html.)

International Students

A matter of current debate, legislation, and policy implementation is the degree to which our university campuses should remain open to international students and scholars. Who should receive student visas? Should there be limitations on what foreign-born students can study? What criteria should be applied when answering such questions?

American research universities hold deep and longstanding values of openness in scientific research and education. Yet we must test these values and their implications against the realities of the catastrophic terrorist acts that left 3,000 dead within our borders in a single, horrific day. The fact is that an environment requiring careful evaluation of these values and their security implications had developed well before September 11, 2001.

For decades, the outward diffusion of people, ideas, and collaboration from our universities has been celebrated as important and timely. This diffusion has been accelerated by the Internet and the World Wide Web, and by the rapid evolution of globalization and internationalization.

These forces of openness and outward pull are now opposed by concerns about their possible implications for our vulnerability to terrorism and for the nation's broader posture regarding export controls on certain technologies and information.

Clearly, the resolution of these issues requires an ongoing, substantive dialogue between the academic community and the Federal government. In my view, during the past twelve months, such a dialogue has begun and in general has proceeded well toward reasoned resolution of several core issues. Nonetheless, the underlying sense of partnership is fragile and is vulnerable to political winds that can shift in a moment. It would be devastating to our long-term national interest if substantive dialogue and mutual problem solving were not continued.

The MIT Context

Let me begin with the MIT context. Approximately nine percent of our under-graduate students are international. They come from 88 countries. About 37 percent of our graduate students are international. They come from 91 countries. Across our institution, there is a deep belief that these young men and women contribute immensely to MIT's educational environment—one in which all students are exposed to a variety of cultures, personal experiences, and worldviews.

These international students are the best and brightest from their nations and they strongly enhance the excellence of learning and research at MIT. They are not some spice added to the mix; rather, they are an integral and highly valued part of what makes MIT great. Furthermore, the industries and institutions in which our graduates will live and work are highly globalized, so that even from a purely pragmatic perspective, cross-cultural and cross-national learning and experience are highly valuable and in our national interest.

MIT has a long tradition of educating both immigrants and citizens who have often been the first in their families to go to college. Although we maintain no data to confirm it, my impression is that many of our students are U.S. citizens whose parents came to this country from elsewhere. Engineering and science in this country have traditionally been pathways up the ladder to economic success and productive contribution to our society.

If ever there were a meritocracy, it is the MIT Faculty, which has selected many in its ranks from those who have come to this country from elsewhere. The recent Nobel laureates on the MIT Faculty include people born in Japan, India, Mexico, Italy, and Germany, as well as the United States. Most of them came to this country as graduate students. Or consider our Institute Professors, the dozen or so faculty members who have achieved the highest faculty rank at MIT. They were born in the United States *and* in Belgium, Italy, Mexico, Israel, and China. Any of our great universities would offer similar lessons.

The preponderance of our graduates appear to have remained in this country, contributing to the ranks of other faculties and the leadership of our high-tech industries, and participating broadly in our ongoing civic enterprise. Today, it is widely assumed, though not well documented, that as economies have improved around the world, especially around the Pacific Rim, more graduates are returning home than has been the case previously.

And those who have returned to their native countries have frequently contributed greatly to their leadership and to their industries. They take to their nations new knowledge and training that can grow strong economies and attenuate the inequities that are at the core of world strife. MIT's Department of Economics has graduated many PhDs who went on to become economic ministers or other high- level officials around the world. The Sloan Fellows Program of advanced executive education has had a large international enrollment from its inception. Sloan Fellows are found all over the world in leadership roles. A visitor to practically any country will find MIT-educated engineers and scientists leading faculties and industries. The vast majority carry with them an understanding of and respect for our institutions and for many of our national values and characteristics.

Have MIT graduates returned to other countries and worked against the interests of the United States? There are undoubtedly a few such instances, given the large numbers of graduates and the ebb and flow of history. There were examples of this in China during the Cold War and elsewhere, just as a tiny few of the tens of thousands of our U.S. citizen graduates may have been less than a source of pride. I can draw no conclusion, however, other than that MIT, the United States, and the world have overwhelmingly benefited from the international character of our student body.

The National Context

What is the broader national context?

Over the last 25 years, the number of foreign-born scientists and engineers in the U.S. has grown in all degree levels, in all sectors, and in most fields of study. The largest group of foreign students are those studying in our business schools. Currently, 25 percent of all U.S. doctorate holders, and roughly 45 percent of PhD engineers and computer scientists, were born abroad. One-third of the science and engineering PhDs working in our industries were born elsewhere, with this number exceeding 50 percent in engineering and computer science.

Over the years, the dominant national origins of international students studying science, engineering, and computer science in the U.S. have shifted, largely propelled by the strength of various national economies, and attenuated by political conflicts. When I was a young faculty member, the largest numbers of international students in U.S. engineering programs came from Iran and Nigeria. Today, they come from Asian countries.

When considering the large influx of international students in engineering and science, we must recognize that these demanding studies and professions are not highly valued in our popular or political cultures. It is incumbent on us to strengthen our K-12 science and math education, and for the government and private sector to maintain exciting research and educational environments to attract bright young Americans. I should note that as federal funding for biomedical research has dramatically increased during the last few years, the percentage of doctorates in that field granted to U.S. citizens has begun to increase, albeit slowly.

As we consider the implications for homeland security of our openness to international students, we should be cognizant that other national emergencies have raised similar questions in the past. In the late 1970s, during the Iranian hostage crisis, grave concerns were raised about Iranian students in this country, and strong actions were contemplated, and to some extent taken, against them. In the late 1980s and early 1990s, MIT and other universities were castigated because of our visitors from, and interactions with, Japan. It was feared that the Japanese would milk advanced technology from our university laboratories, commercialize it, and drive our economy into the ground. Indeed, a U.S. senator widely circulated a diagram titled "The Circle of Shame" with MIT depicted at the heart of this presumed nefarious activity.

Three Conclusions

From this background and context, I draw three conclusions:

- The openness of U.S. research universities to foreign students and scholars has been overwhelmingly successful in building the excellence of our institutions, enhancing the educational experience of our students, contributing to American industry and academia, furthering the advancement of nations around the world, and disbursing good will toward and understanding of our system and values.
- Nationally, the proportion of foreign students in science and engineering doctoral programs continues to grow. This, however, is largely a reflection of problems in our secondary educational system coupled with a popular culture that does not promote or value the dedication and long years of hard work required for success in these fields.
- Our openness to international students and scholars has been questioned or reviewed many times throughout our history, including during the most recent decades.

We now find ourselves in perilous times that require that we consider, in partnership with our Federal government, whether our openness to foreign students requires modification. Indeed, statutory requirements for such determinations are already in place. We have the harsh reality that a few of those responsible for the bombing of the World Trade Center in 1993, and the mass killings in New York, Washington and Pennsylvania last year, entered this country on student visas. We also have the concern that future catastrophic terrorism—unlike that committed to date—might require advanced scientific knowledge or materials that could be acquired in university classrooms or laboratories.

Thus two questions are raised: Should we track the whereabouts of foreign students, and should there be restrictions on what they study?

Tracking International Students

Students and visiting scholars must be issued visas by U.S. consular officers around the world after they have been admitted to study at a U.S. university. The consuls have the responsibility for judging the appropriateness of admitting each such student. This is the proper division of labor—universities evaluate academic credentials, and federal officials in the State Department determine admissibility to the United States.

It is broadly agreed that once students arrive in this country universities should maintain and provide to the government fundamental "directory information" including whether each individual is enrolled and what area of study he or she is pursuing. It certainly is legitimate for the government to track non-immigrant students and scholars, and determine whether they are pursuing the purposes for which they were admitted. Despite numerous comments by journalists and politicians to the contrary, the higher education community has supported, and continues to support, such tracking.

The problem has been that this information, which is already collected by the universities, gets buried in a vast amount of paper that cannot be processed or analyzed in a timely manner. A new computer system, SEVIS (Student and Exchange Visitor Information System), is under rapid development to correct this situation. MIT supports the deployment of SEVIS, and so does every major higher education association.

Sensitive Areas of Study

Presidential Decision Directive No. 2, issued by President Bush in October 2001, requires that the Federal government, in consultation with the higher education

community, determine "sensitive areas of study" that should be off limits to students from certain nations.[1] Even this is not a new concept. There has existed for some time a State Department system called Mantis that is alerted when a potential student from certain countries applies to study in a field that appears on the Technology Alert List, e.g., nuclear engineering, lasers, sensors, ceramics, radar, electronic guidance systems, or munitions. The State Department must then generate a specific opinion as to whether the student should be granted a visa.

Nonetheless, I am deeply concerned about where implementation of this directive could lead. The basic framework, developed by the White House in consultation with agencies such as the State Department and the Department of Justice, and with considerable discussion with the higher education community, is fundamentally sound. The core of this framework is the Interagency Panel on Advanced Science and Security (IPASS). The proposed task of IPASS is widely understood to be to determine whether students or scholars applying to enter the U.S. will engage in research activities that provide access to advanced science or technology of direct relevance to the development, deployment, or delivery of weapons of mass destruction.

This framework, if I have accurately portrayed it, has two important positive features. First, it establishes a high-level review panel, rather than generating a list of specific subjects or courses considered off limits. Second, it applies to matters associated with weapons of mass destruction, which, as I will explain later in this essay, seems appropriate to me. Third, it places this judgment with the admitting authorities *at the time of visa application*, thus maximizing the openness of our institution to students once they are properly admitted to the U.S.

Where could the IPASS framework go wrong and unreasonably disrupt the basic workings of research universities? I would suggest the following potentialities as troubling or inappropriate:

- Moving beyond criteria that are based rather narrowly on weapons of mass destruction.
- Expanding criteria to cover academic courses and classes, rather than very specific research and development activities.
- Applying new academic restrictions to students after they have begun to study at the institution for which they were properly granted a visa.

Indeed, the MIT Ad Hoc Committee on Access to and Disclosure of Scientific Information, chaired by former U.S. Secretary of the Air Force Sheila E. Widnall, in its report *In the Public Interest*, recommended that "No foreign national granted a visa by the U.S. government should be denied access to courses, research or publications generally available on campus."[2]

This Committee further stated, "The well-being of our nation will ultimately be damaged if education, science, and technology suffer as a result of any practices that indiscriminately discourage or limit the open exchange of ideas."

"We recommend that no classified research should be carried out on campus; that no student, graduate or undergraduate, should be required to have a security clearance to perform thesis research; and that no thesis research should be carried out in [intellectual] areas requiring access to classified materials."

Scientific Materials and Information

Terrorism to date has been decidedly low-tech, although its worst instances have been very sophisticated organizationally. Truck bombs, commandeering of commercial aircraft, and credit card fraud appear to have been the primary tools used by those who have done us great harm. The materials they used have been things such as fertilizer, diesel fuel, and off-the-shelf chemicals. None of this has involved scientific or technical information that is advanced, or difficult to obtain. This is an important observation, although no guarantee of the future course of events. Indeed, the as-yet undetermined origin of anthrax attacks in the U.S. gives rise to important concerns.

The nebulous, diffuse nature of terrorism makes a simple prescription for the responsibilities of academic institutions impossible. Nonetheless, let me suggest a basic framework for thinking about it, by parsing the issues among the most commonly discussed mechanisms for terrorist attacks of a technological nature.

This framework reflects the nature of the information and materials required:

- The use of ***nuclear weapons and missiles*** is a singular matter. The information required to construct a nuclear weapon is acquired over many years. It is generally not the stuff of classroom learning; rather it is largely sophisticated know-how developed by experience, testing, and advanced computational simulation. Most nations can only acquire the critical components and materials required for construction of a nuclear weapon by illegal means.

[1] "Homeland Security Presidential Directive – 2", October 29, 2001, President George W. Bush.

[2] In the Public Interest, Report of the Ad Hoc Faculty Committee on Access to and Disclosure of Scientific Information, Massachusetts Institute of Technology, Sheila E. Widnall, Chair, June 12, 2002, page 15; subsequent citations at pages ii and iii.

- ***Cyberterrorism*** is the use of computer and communication technology to disrupt, corrupt, or disable our military or commercial IT systems. Potentially it could directly weaken our national security, or it could bring havoc to our economy. The information required by a cyberterrorist can be presumed to be of varying degrees of sophistication, but generally available. It is largely the stuff of hacking. The materials, in this case, are computers and access to the Internet. Having said this, cybersecurity is an urgent issue in all domains of industry, education, and government. It imposes additional administrative burdens and regulatory costs on all organizations, and it calls for more computer scientists and mathematicians who are U.S. citizens, trained to protect our information infrastructure.
- ***Bioterrorism*** could involve the propagation of disease and the defeat or disruption of therapies to counter it. The information required is likely to be available in published literature. Some experientially gained know-how might be involved, but it could generally be obtained by a wide variety of experiences in laboratories, medical establishments, or pharmaceutical companies. Some specialized equipment or facilities might be required, but they would likely have widespread applicability to legitimate activities. This situation is distinctly unlike the case of nuclear weapons and poses some of the most vexing issues. The needed biological materials may or may not be readily available.
- ***Chemical or explosive attacks*** are somewhat less commonly discussed, but are, in my view, among the things we should be most worried about. The information required for many forms is readily available, even to the layperson. Some dangerous agents are difficult to obtain, but others can be purchased off the shelf. The terrible destruction of lives by an angry American at the Alfred P. Murrah Building in Oklahoma City and the use of Sarin gas in Tokyo are prime examples.

Having reviewed these categories, I would say that nuclear weaponry seems to be an almost singular case. Critical knowledge and know-how should be, and is, highly restricted by the normal security classification processes of the Department of Defense and the Department of Energy. These are not things that students should be required to access in the conduct of university research; they cannot be taught in a normal classroom. It is an area that, in my view, is appropriate for reasoned decision-making by IPASS. But we should depend primarily on our well-established classification and security mechanisms.

I do not believe that cyberterrorism, bioterrorism or the use of chemical explosives pose threats that could in a meaningful way be countered or avoided by restrictions on what is taught in our university classrooms, or on the country of origin of our students. This is basic knowledge, and as in most instances in life, basic knowledge can be used for good or ill. The knowledge of what makes a virus virulent is also the key to medical therapies and disease prevention. This may be an uncomfortable reality, but it is a reality.

The *material* (as distinct from the information) needed to cause terror by chemical or biological means is a different matter. It is a clear responsibility of universities to not be a source of such materials for use by those who would do harm. Access to pathogens and dangerous chemicals must be carefully restricted and monitored in the normal course of doing science. Inventories should be minimized. Location, quantities, and security should be maintained effectively and accurately. We are working hard to establish best practice in this regard at MIT.

It is the further responsibility of universities to educate all of their research and laboratory students about security issues regarding their materials and equipment. This should be integrated with education and training regarding the health, safety, and environmental responsibilities of laboratory practice. Things as basic as not working alone in chemical and biological laboratories must be reinforced.

Select Agents

The term "select agent" came into the scientific vernacular when, on June 12, 2002, the President signed into law the Public Health Security and Bioterrorism Preparedness and Response Act of 2002 (H.R. 3448, Pub. L. 107-188).

As a first step in this law, all researchers in the life sciences were required to report to their institution and to the government (Department of Health and Human Services) by September 10 their inventory of 40 "select agents" that might be used as bioweapons. Other provisions of the law will include similar reporting requirements for potentially lethal agricultural materials and security measures for laboratories that keep such agents. In addition, only those researchers determined to have a legitimate need will be allowed access to these materials, which will not be available to students or scholars from countries that are considered to be sponsors of terrorism or to people with histories of mental illness or felony or drug convictions.[3]

By and large, the academic community has treated this as a reasonable approach and, of course, will comply with the law. But even this seemingly straightforward approach is not without a huge potential price to be paid in the

[3] See Diana Jean Schemo, "September 11 Strikes at Labs' Doors," *The New York Times*, August 13, 2002, page F1; and David Malakoff, "Tighter Security Reshapes Research," *Science*, September 6, 2002, Volume 297, page 1630.

advancement of science, and therefore in our health and welfare. The MIT Ad Hoc Committee on Access to and Disclosure of Scientific Information was deeply concerned about the path down which we may be starting, noting that the Secretary of Health and Human Services has the statutory power to expand the list of select agents. The Committee expressed the view that we could soon arrive at a level of restriction of access to materials by our students, faculty, or staff on the basis of their citizenship, for example—something that would be incompatible with our principles of openness, and would cause us to withdraw from the corresponding research topics on our campus.

Publication of Scientific Information

The most difficult challenge as we balance prudent measures to maintain our security with the openness that is so essential to America's basic principles, to the excellence of our universities, and to the conduct of science, is associated with publishing information in the life sciences.

Why is this so complicated?

Science is a collective endeavor. Science increasingly is an international endeavor. The weight of these two statements is compounding at lightning speed as the complexity of science increases, and because, like all of society, scientists are tied together through the Internet. Science progresses not just by singular discoveries, but also by the independent verification and interactive discussion of discoveries. Knowledge is honed through ongoing dialogue that takes unexpected twists and turns. It thrives in openness, and suffers in isolation.

Thus, in fields such as microbiology, the very nature of science, when combined with the dual nature of information—i.e., its use for good or for ill—presents a challenge in an environment filled with well-justified concern about terrorism.

I worry that the broad advance of biological science is open to compromise. Restrictions that have been or may be imposed by our government as it struggles to carry out its most fundamental mission of protecting its citizens are not the only issue. The politics of subjects such as in vitro fertilization and stem cell research have removed them from the sphere of federally funded university and government laboratory research, where the mission is to achieve basic scientific understanding. Former Director of the National Institutes of Health Harold E. Varmus, among others, has raised deep concern about distortions in the conduct of these and certain other areas of basic biological research that, as a result of such federal policies, can go forward only in industrial labs, where "commercial realities must be considered along with scientific progress, where full disclosure is not the norm, and where oversight is limited."[4]

Three Suggestions

The resolution of matters of open publication when our security is challenged is not easy. A panel of the National Academy of Sciences has been established to provide guidance on this matter. It is chaired by MIT professor Gerald R. Fink, former director of the Whitehead Institute for Biomedical Research. While looking forward to their wisdom, let me offer three suggestions for the resolution of the issues of sensitive areas of study, select agents, and publication of scientific information:

- First, ***consultation*** by the Federal government with the academic and scientific communities is essential. This must be continuous and directly effective consultation at both the policy and operational levels. As pointed out with great clarity by John J. Hamre, former U.S. Deputy Secretary of Defense, all too often security professionals do not understand or trust scientists, and scientists may be quite unaware of some of the real risks associated with their work.[5] This has been a major problem within the nuclear weapons arena since its beginning. It will be even more complex as we worry about basic research in universities in the diffuse, little-understood context of terrorist threats. But there is no viable alternative to substantive consultation and mutual effort.
- Second, ***distinct boundaries*** must be drawn where it actually is possible and appropriate. It is the ambiguity and uncertainty of what is inappropriate to publish, or in the use by the government of ill-defined terms like "sensitive but unclassified," that creates danger for the scientific enterprise and invites bad decisions. Well before September 2001, difficult issues were arising regarding the application of export controls on the uses of computers and satellites for basic research, and even control of certain unclassified but export-controlled library documents. Productive collaborations with scientists in other countries and the work of non-citizen graduate students and scholars have been prohibited by increasingly broad interpretation of the International Traffic in Arms Regulations (ITAR).

  Similar problems with export control arose in the 1980s. The problem was settled effectively when President Reagan issued National Security Decision Directive 189 (NSDD 189). Basically NSDD 189 stated that scientific information is either classified or unclassified. It generally exempted fundamental

[4] Harold E. Varmus, "The Weaknesses of Science for Profit," The New York Times, December 4, 2001, page A21.

[5] John J. Hamre, "Science and Security at Risk," Issues in Science and Technology, Summer 2002, Volume XVIII, no. 4, pages 51-57.

research from security regulations. This distinct boundary was fundamentally clear and effective for many years. Then, over time, its interpretation by the bureaucracy became increasingly broad and its effectiveness was diminished by application of other statutes—an opportunity afforded by the compromise insertion of one open-ended clause when it was drafted. NSDD 189 should be reaffirmed, and its spirit should be applied in other domains. The default in fuzzy areas should be to keep basic research open and unencumbered.

- Third, we should not underestimate the power of ***voluntary agreements*** within the scientific community. The decisions about publication of detailed results faced by many scientists, especially biologists and biomedical researchers, simply do not lend themselves to decisions by security personnel. In the end, most decisions will be made by the scientists who perform the work being reported, because, given the dynamic evolution of scientific knowledge, they do not lend themselves to simple regulatory rules. We also must be keenly aware that regulations in the U.S. are limited in their effectiveness in an age when important frontier science is done in many nations around the world. (Indeed, the incident that first brought this issue to the public's attention occurred when an Australian group reportedly learned how to make a virus related to smallpox 100 percent virulent.) It may be that the most effective thing to do is to create a framework or forums from which scientists can gain guidance and advice from their peers as they wrestle with such daunting decisions.

  Here too there is precedent of sorts. In the war years preceding the development of the atomic bomb, allied scientists stopped publishing research associated with uranium physics, although they continued to discuss the topic privately among themselves. And when recombinant DNA first became possible, leading scientists, led by David Baltimore, established a moratorium on their work, pending open discussion among themselves and a wide range of lay people to establish standards. Work and open publication proceeded smoothly thereafter. Neither of these examples provides a direct guidance for the less focused situation we face today, but the point is that the scientists themselves, in consultation with many others as appropriate, found an effective path forward.

In Conclusion

The debate about security and openness is not new. In 1958 Norbert Wiener opined, "To disseminate information about a weapon ... is to make practically certain that it will be used."[6] As if in rejoinder, Edward Teller said in 1987 that "Secrecy is not compatible with science, but it is even less compatible with democratic procedure."[7] These statements by two brilliant scientists with experience in defense work reflect the fact that virtually all science and engineering knowledge, or most other knowledge for that matter, can be used for good or ill.

This certainly does not mean that we can wash our hands of the responsibility to address hard questions about the safety and security of our fellow citizens. But in an age when the "weapon" may be a truckload of explosives, a computer virus, a commandeered aircraft, or finely milled bacterial spores, "dissemination of information" is a nebulous matter. And in an age when the rapid advance of science and technology is essential to sustaining our health, economy, and quality of life, Teller's observation is of crucial importance.

Traditional American values of openness in education and research must prevail. But this will be possible only if we in research universities contribute our talents to maintaining the security of our homeland, and if the Federal government and academia maintain a respectful, substantive, and effective dialogue between those who do science and those who are charged with protecting the nation.

Charles M. Vest
President

[6] Norbert Wiener, quoted in Robert Jungk, Brighter than a Thousand Suns, Penguin Books, 1958.

[7] Edward Teller, Better a Shield than a Sword: Perspectives on Defense and Technology, The Free Press, 1987.

In Special Recognition

The academic year 2001–2002 saw a number of changes to MIT's senior academic and administrative leadership.

J. David Litster stepped down from his position as vice president and dean for research. During ten years in that role, Professor Litster made a major contribution to maintaining the excellence of MIT's large interdepartmental laboratories during a turbulent period of changing federal research support and priorities. A physicist recognized internationally for pioneering experimental and theoretical studies of phase transitions in unusual states of matter and statistical mechanics, he will return to research and teaching.

Alice Petry Gast joined the Institute as vice president for research and associate provost, with responsibility for the coordination of policy regarding research and graduate education, as well as oversight of the large laboratories that operate across school boundaries. Formerly a member of the faculty at Stanford University, Professor Gast also assumed the Robert T. Haslam Professorship of Chemical Engineering.

Claude R. Canizares, the director of the Center for Space Research and the Bruno Rossi professor of physics, was appointed associate provost. In his new position, he assumed primary responsibility for the oversight of MIT Lincoln Laboratory on behalf of the provost as well as a major role in the Institute's relationships with the federal government, particularly the major funding agencies in the executive branch. He also assumed oversight of space usage and planning, as well as responsibilities traditionally held by the associate provost, including handling confidential investigations on behalf of the president and provost.

Professor Wesley L. Harris was appointed one of the co-chairs of the Institute-wide Council on Faculty Diversity, charged with formulating plans for the recruitment and advancement of women and minority faculty throughout the Institute. The other co-chairs are Nancy H. Hopkins, the Amgen professor of biology, and the provost. Professor Harris succeeds Chancellor Phillip L. Clay, who remains a member of the council.

Two new associate deans began service during the academic year—in the School of Architecture and Planning, associate professor of architecture Terry W. Knight, and in the School of Humanities, Arts, and Social Sciences, professor of political science Charles Stewart III.

New academic department or program leaders whose service began during the year were Rohan Abeyaratne and Thomas G. Gutowski, respectively head and associate head, Department of Mechanical Engineering; Stephen A. Benton, academic head, Program in Media Arts and Sciences; Robert Kanigel, acting head, Program in Writing and Humanistic Studies; Steven R. Lerman, deputy director, Singapore-MIT Alliance; Barbara H. Liskov, associate head, Department of Electrical Engineering and Computer Science; Chiang C. Mei, acting head, Department of Civil and Environmental Engineering; and Elizabeth A. Wood, director, Program in Women's Studies.

Susan L. Lindquist, formerly of the University of Chicago, joined the Department of Biology and was elected director of the MIT-affiliated Whitehead Institute for Biomedical Research, succeeding Professor Gerald R. Fink, who completed a decade of distinguished service as director. Other notable changes in the leadership of research activities included the appointments of Cynthia Barnhart, co-director, Center for Transportation Studies; Charles L. Cooney, faculty director, Deshpande Center for Technological Innovation; Jacqueline N. Hewitt, director, Center for Space Research; Tyler E. Jacks and Jacqueline Lees, respectively director and associate director, Center for Cancer Research; and Victor W. Zue, interim director, Laboratory of Computer Science.

Among notable changes in the administration during the past year were the appointments of John DiFava, chief, Campus Police; Anne H. Margulies, executive director, MIT OpenCourseWare; Amitava (Babi) Mitra, executive director, Academic Media Production Services; and Elizabeth A. Reed, director, Office of Career Services and Preprofessional Advising.

Awards and Honors

The awards received by MIT faculty, students, and staff testify to the distinction of the Institute's programs and its people. Here we note only some of the honors and recognition earned by members of the Institute community during 2001–2002.

Wolfgang Ketterle, the John D. MacArthur professor of physics, was awarded the Nobel Prize for Physics for 2001, sharing the honor with two MIT alumni, Eric A. Cornell of the National Institute of Standards and Technology and Carl E. Wiemann of the University of Colorado at Boulder. The Swedish Academy of Sciences recognized the three for the achievement of Bose-Einstein condensation and early fundamental studies of the properties of the condensates—a new state of matter in which the atoms of a supercooled gas lose their individual identities and act as a matter wave displaying uniform behavior. A total of eight graduates, faculty, and former faculty from MIT were awarded Nobel Prizes in 2001, in chemistry, economics, medicine, and peace as well as physics.

Ann M. Graybiel, who holds the Walter A. Rosenblith Professorship of Brain and Cognitive Sciences, and is a member of the McGovern Institute for Brain Research, was among those awarded the 2001 National Medal of Science, the nation's highest honor in science and technology. Separately, her MIT colleagues awarded Professor Graybiel the James R. Killian Faculty Achievement Award for 2002.

Professor Graybiel's research on the large forebrain region known as the basal ganglia has had a profound impact on studies of the functional anatomy and physiology of the brain, and offers promise of new understandings of the scientific substrate for human disorders affecting movement and cognition.

The National Academy of Engineering awarded Robert S. Langer, the Germeshausen professor of chemical and biomedical engineering, the Charles Stark Draper Prize, which recognizes innovative engineering achievement for a body of work extending over a period of years, with a proven contribution to human welfare. Professor Langer was honored for his invention of medical drug-delivery technologies that prolong lives and ease the suffering of millions of people every year.

The Institute's Lincoln Laboratory, which celebrated its fiftieth anniversary of service to the nation in 2002, was honored with the Secretary of Defense Medal for Outstanding Public Service. Secretary of Defense Donald Rumsfeld cited the laboratory for contributions to the development of critical defense capabilities that have enhanced the nation's security and for strengthening the nation's economy through the transition of innovative technologies to industry. This was only the second time that the medal, normally given to an individual, has been presented to an organization; the first time was in honor of the laboratory's twenty-fifth anniversary.

MIT reserves the title of Institute Professor for a small number of faculty members of particular distinction, who are recognized by their peers for exceptional leadership, accomplishment, and service in the scholarly, educational, and general intellectual life of the Institute and of the wider academic community. In the spring of 2002, Emilio Bizzi, the Eugene McDermott professor in the brain sciences and human behavior, and a member of the McGovern Institute for Brain Research, was named Institute Professor in recognition of pioneering work in the field of motor control and sustained contributions to the academic and community life of MIT.

Three members of the MIT faculty were elected to membership in the National Academy of Sciences, one of the highest honors in American science. John P. Grotzinger, the Schrock professor of earth sciences, and Vernon M. Ingram, the John D. MacArthur professor of biology, were elected members. Wolfgang Ketterle was elected a foreign associate, a category of nonvoting membership open to those without US citizenship.

Five members of the MIT faculty were elected to fellowship in the American Academy of Arts and Sciences: Professors Joshua Cohen of the Departments of Philosophy and Political Science; James G. Fujimoto of the Department of Electrical Engineering and Computer Science; Alice P. Gast; Michael J. Hopkins of the Department of Mathematics; and Philip S. Khoury of the Department of History, Kenan Sahin dean of the School of Humanities, Arts, and Social Sciences. Also elected to membership was senior research scientist David D. Clark.

The National Academy of Engineering elected to membership four current or emeritus members of the Institute Faculty: Professors Berthold K. P. Horn of Electrical Engineering and Computer Science, Klavs F. Jensen of Chemical Engineering and Materials Science and Engineering, James C. Keck of Mechanical Engineering, and Subra Suresh of Materials Science and Engineering.

Senior research scientist Timothy J. Berners-Lee, director of the World Wide Web Consortium and holder of the 3Com Founders Chair at the Laboratory for Computer Science, received two major awards this past year: the Japan Prize in the field of computing and computational science and engineering, awarded by the Science and Technology Foundation of Japan, and the inaugural Sir Frank Whittle Medal of the United Kingdom's Royal Academy of Engineering.

International scholarships recognized MIT students for their demonstrated accomplishments and remarkable promise of achievement. Senior Sanjay Basu and alumnus Paul K. Njoroge '00 were both awarded Rhodes Scholarships for study at Oxford University, while senior Daniel P. Riordan received a Churchill Scholarship for study at the University of Cambridge.

MIT president Charles M. Vest was appointed to President George W. Bush's Council of Advisors on Science and Technology. Dr. Vest served on President Clinton's Committee of Advisors on Science and Technology from 1993 to 2001.

This year, five members of the faculty were named MacVicar Faculty Fellows in honor of their accomplishments and innovative methods as teachers: Professors Alan H. Guth of Physics, Steven R. Hall of Aeronautics and Astronautics, Kip V. Hodges of Earth, Atmospheric and Planetary Sciences, Nancy G. Kanwisher of Brain and Cognitive Sciences, and David Thorburn of Literature.

Peter H. Seeberger, the Firmenich career development assistant professor of chemistry, was presented with the Harold E. Edgerton Faculty Achievement Award, which recognizes junior faculty for achievements in teaching, research, and service to the MIT community.

This year the Institute presented the Gordon Y Billard Award to three members of the staff in recognition of special services of outstanding merit: Steven M. Dimond, manager of the Copy Technology Centers; Charlene M. Placido, assistant dean for research; and Albert J. Guarino, ormitory housekeeper in Next House.

In Memoriam

The accomplishments and honors of MIT's current faculty, staff, and students are the latest link forged in an unbroken chain of distinguished lifetime achievement by members of the MIT community. Each year at this time, we recognize the many contributions to MIT—and to the larger society it serves—made by current and former colleagues who have recently passed away. Their sterling legacy remains a source of inspiration for all of us, and for future generations of the MIT family.

Computer visionary Michael L. Dertouzos, professor of computer science and electrical engineering and director of the Laboratory of Computer Science (LCS), died on August 27, 2001, at the age of 64. Born in Athens, Greece, he came to the United States as a Fulbright Scholar at the University of Arkansas. After earning his doctorate at MIT, he rose through the faculty ranks, becoming a full professor in 1973. He became director of LCS in 1974, and under his leadership the laboratory helped develop such innovations as time-shared computers, RSA encryption, and the ArpaNet. Throughout his career Professor Dertouzos believed that computer technology would not achieve its full potential until its development was more closely integrated with human values and needs. He was responsible for bringing the World Wide Web Consortium to MIT, and in 1999 he launched an ambitious partnership between LCS and the Artificial Intelligence Lab—Project Oxygen—to make computer usage a more natural and ubiquitous part of daily living.

Peter Elias, the Edwin S. Webster professor emeritus of electrical engineering, whose work in the coding and transmission of binary data became a cornerstone for much of modern digital communications technology, died at the age of 78 on December 7, 2001. Born in New Jersey, he earned his undergraduate degree from MIT in 1944. After Navy service, he received two master's degrees and his PhD from Harvard University, returning to MIT in 1953 as an assistant professor. Appointed associate professor in 1956, he became a full professor in 1960 and that same year became the youngest person to head the Department of Electrical Engineering and Computer Science. He joined the Laboratory for Computer Science in 1976. Throughout his career, he engaged in public and professional service work, serving on the President's Science Advisory Committee on Computers in Higher Education and chairing the Information Theory Group of the Institute of Electrical and Electronic Engineers. He was co-founder and a longtime editor of the journal *Information and Computation*.

Professor emeritus of music David M. Epstein died on January 15, 2002, at the age of 71. A 1952 graduate of Antioch College, he held graduate degrees from the New England Conservatory, Brandeis University, and Princeton University, where he received a PhD in 1968. After teaching at Antioch and at Sarah Lawrence College, he joined the MIT faculty in 1965 as associate professor. Beloved conductor of the MIT Symphony Orchestra for a third of a century, he also served as music director of orchestras in Harrisburg, Pennsylvania, and Worcester, Massachusetts, and appeared as a guest conductor with more than two dozen orchestras in nine countries. He was appointed a full professor in 1971 and served two terms as head of the Department of Music during the 1980s. His research on the role of time and motion in music throughout the world led to the publication of two books on the subject and a visiting fellowship at the Neurosciences Institute in La Jolla, California.

F. Leroy Foster, a leader in the organization of research at MIT, died on December 31, 2001, at the age of 99. A Massachusetts native, he earned three MIT degrees and served as assistant professor of mining and metallurgy from 1931 to 1940. In 1939 Dr. Foster became assistant director of the Institute's Division of Industrial Cooperation (DIC). At the time, DIC oversaw 25 research contracts totaling $200,000; by 1945, it had grown to manage 150 projects with a value of $40 million—nearly $395 million in 2002 dollars. Dr. Foster was named director of the DIC in 1955 and a year later became director of the newly formed Division of Sponsored Research, which absorbed DIC. He retired from DSR in 1968, but remained active as the head of the Lowell Institute School and as a staunch supporter of the MIT Association of Alumni and Alumnae, which awarded him its highest honor, the Bronze Beaver, in 1959.

Samuel A. Goldblith, former professor of food science and technology and Institute vice president, died on December 28, 2001, at the age of 82. As a lieutenant in the US Army, he endured the notorious 1942 Bataan Death March and three years as a prisoner of the Japanese. A member of the Class of 1940, he credited his MIT education with helping to preserve his and others' lives during his captivity: among other improvisations, he extracted vitamins from inedible grasses. Awarded two Bronze Stars and a Silver Star for heroism, he returned to MIT after the war to continue his studies, receiving an SM in 1947 and his PhD in 1949. He was named a professor of food science and technology in 1959 and became a leading researcher in the domestic use of microwave ovens and in freeze-drying. He directed the Industrial Liaison Program from 1974 to 1976 and was MIT's vice president of resource development from 1978 to 1986. His many legacies to MIT include the Samuel A. Goldblith Career Development Professorship and the MIT Japan Office, which he helped to establish in 1976 as part of his personal effort to heal postwar enmity between the United States and Japan.

Professor of modern languages and linguistics Kenneth L. Hale, an expert on the common characteristics of native languages around the world, died on October 8, 2001, at the age of 67. He learned that he had a gift for languages

while in school in Arizona with speakers of Native American languages. By the time he had graduated from the University of Arizona, he was well on his way to mastering what would ultimately total over 50 languages. He went on to earn an MA and a PhD in linguistics from the University of Indiana-Bloomington, embarking on a career that included research on aboriginal languages in Australia and academic appointments at the University of Illinois-Urbana and the University of Arizona. He joined MIT in 1967 and established himself as an expert in cross-linguistics and the universal principles of language formation. He was one of the world's foremost preservationists of endangered languages, which he viewed as priceless repositories of cultural knowledge and human history.

Alfred A. H. Keil, an authority on naval architecture who served as dean of the School of Engineering from 1971 to 1977, died on January 9, 2002, at the age of 88. Born in Germany, he received his doctorate from Friedrich Wilhelm University in 1939 and during the war years studied the physics and effects of underwater explosions. He worked for the US Technical Mission after the war, arriving in the United States in 1947 to join the Navy's Bureau of Ships, where he quickly won a reputation as an expert on ship protection and structural integrity. He came to MIT in 1966 to head the Department of Naval Architecture and Marine Engineering (now Ocean Engineering), where he developed a joint degree program with the Woods Hole Oceanographic Institute and established MIT as the first private university to be designated a Sea Grant College. He retired, as Ford professor of engineering emeritus, in 1978. Dean Keil's broad vision of engineering education has cited as an inspiration for important innovations in teaching and research such as the establishment of the Engineering Systems Division and the new Undergraduate Professional Opportunities Program.

Institute Professor emeritus Gyorgy Kepes, an artist and aesthetic theorist who founded MIT's Center for Advanced Visual Studies (CAVS), died on December 29, 2001, at the age of 95. A native of Hungary, he attended Budapest's School of Arts before becoming a collaborator of Laszlo Moholy-Nagy, a principal figure in the Bauhaus Movement of the 1930s. He followed Moholy-Nagy from Berlin to Chicago, becoming head of the Department of Light and Color at the New Bauhaus. In 1946, he came to MIT as an associate professor of visual design. He was appointed full professor in 1949 and was named an Institute Professor in 1970. He founded CAVS in 1967 and served as its director until 1972. An advocate of new media for artistic expression, he made the Center a home for artists who employed lasers, holograms, plasma sculpture, and sky art to realize their creative visions. He himself was a prolific designer, sculptor, writer, and painter who won commissions and awards throughout the world. In the 1990s, the Hungarian government endowed a museum to house his paintings, and awarded him the Medal of Honor and the Middle Cross. MIT's Council for the Arts awards the Gyorgy Kepes Fellowship Prize annually to a member of the MIT community whose creative work reflects the vision and values of Professor Kepes.

Patrick Leehey, professor emeritus of mechanical and ocean engineering and founder of MIT's Acoustics and Vibration Laboratory, died on March 4, 2002, at the age of 80. He attended the University of Iowa and the US Naval Academy prior to embarking in 1942 on a naval career that included combat in the Pacific. After the war, he remained in the Navy while earning a PhD in applied mathematics from Brown University. He subsequently joined the Office of Naval Research in Washington, where he developed hydrofoil craft. By the early 1960s, he was directing the Navy's newly established Acoustics and Vibration Laboratory and had won national awards for his work in ship silencing. Retiring from the Navy in 1964 at the rank of captain, he took up a joint appointment as associate professor in MIT's Departments of Naval Architecture and Mechanical Engineering. Promoted to full professor in 1967, he taught graduate courses on flow noise, boundary layer theory, acoustics, and vibration. After his retirement in 1992, he continued to teach courses, including an Edgerton Center seminar in digital and darkroom imaging that combined his skills in computers and photography.

Professor of nuclear engineering Lawrence M. Lidsky died March 1, 2002, at the age of 66. A graduate of Cornell University, in 1962 he received a PhD in nuclear engineering from MIT and was appointed assistant professor. He was promoted to associate professor in 1968 and full professor in 1976; in 1978, he became associate director of the Plasma Fusion Center. He resigned from the Plasma Fusion Center not long after he published in 1983 a trenchant analysis of the technical challenges inherent to fusion power. He went on to become a leading supporter of a Modular High Temperature Gas Cooled Reactor, powered by fission and safe from meltdowns. Initially ignored, his proposals now enjoy growing popularity, with plants under development in Japan and elsewhere. A dedicated and effective teacher, he directed more than 80 graduate theses and was active in the MIT *Faculty Newsletter*, which he helped to establish. His love of science and engineering was apparent in every aspect of his life, from the design of kayaks to the making of his own wine.

Henry M. Paynter, professor emeritus of mechanical engineering and developer of the Bond graph modeling language, died on June 14, 2002 at the age of 78. He spent his entire academic career at MIT, where he earned an SB in civil engineering in 1944, an SM in mathematics and science in 1949, and the ScD in hydroelectric engineering in 1951. Joining the Department of Civil Engineering in 1946, he became an assistant professor in 1951. He signed on half-time with the Mechanical Engineering faculty in

1954 to initiate a systems engineering curriculum, and by 1959 he was working full time in mechanical engineering. In 1960, he was promoted to associate professor; in 1964, full professor. Recognized in the analysis, design, and control of complex multimedia systems, he held six patents on tension-actuator based robotics technology. His awards included the Alfred Noble Prize of the Joint Engineering Societies in 1953 and the Oldenburger Medal of the American Society of Mechanical Engineers. Professor Paynter was active in environmental causes, notably woodlands preservation; after retiring to Vermont he studied the career of Samuel Hopkins of that state, who in 1790 received the first patent issued by the new US government.

Robert J. Richardson, former member of the MIT Corporation and retired chairman of Bell Canada, Ltd., died on May 11, 2002. He received his PhD in chemical engineering from MIT in 1954 and was active in the MIT Alumni Association for many years. He served as a member of the Chemical Engineering Visiting Committee from 1978 to 1990, a member of the Corporation from 1985 to 1990, and a member of the Athletics Visiting Committee from 1993 to 1997. In addition, he was a regional chairman and national co-chair for the *Campaign for MIT: 1988-1992*. Prior to assuming the helm of Bell Canada, he was a vice president of DuPont. He served on a wide range of corporate and philanthropic boards, including those of the Trans-Canada Pipelines Co., New York Life Insurance Co. and the New York Life Foundation, Northern Telecom Ltd., the TD Bank Financial Group, Inco Ltd., the IMI Foundation, and the Clinical Research Institute of Montreal.

Walter A. Rosenblith, Institute Professor emeritus, former provost, and innovator in the use of computers and mathematical models to study brain function, died on May 1, 2002, at the age of 88. Born in Vienna, he studied there and throughout Europe, receiving degrees from the University of Bordeaux (1936) and the École Supérieure d'Électricité, Paris (1937). In 1939, he came to the United States to study the effect on humans of industrial noise. Prevented from returning to France by the outbreak of war, he taught physics at New York University, the University of California at Los Angeles, and the South Dakota School of Mines and Technology. In 1947, he became a research fellow at Harvard University's Psycho-Acoustic Laboratory. He joined MIT in 1951 as an associate professor of communications biophysics in the Department of Electrical Engineering, became full professor in 1957, and was named Institute Professor in 1975. Chair of the MIT Faculty from 1967 to 1969, he served as associate provost from 1969 to 1971 and provost from 1971 to 1980. As provost, he played a central role in developing the health sciences and biomedical engineering at the Institute and in fostering attention to the interplay of science, technology, and society. One of the few scholars elected to all three of the national academies—Sciences, Engineering, and the Institute of Medicine—he received numerous awards including the French Legion of Honor, Germany's Alexander von Humboldt Medal, and the Okawa Prize. His contributions are recognized at MIT through a professorship established in his honor in 1994 and graduate fellowships named in his honor in 1997.

Professor emeritus of physics Felix M. H. Villars, a pioneer in biological physics and a leader in the development of the Harvard-MIT Division of Health, Sciences and Technology (HST), died on April 27, 2002, at the age of 81. Born in Switzerland, he graduated in 1945 from the Swiss Federal Institute of Technology (ETH) in Zurich and went on to earn his doctorate there in 1946. From 1946 to 1949, he remained at ETH as a research assistant, collaborating with Nobel laureate Wolfgang Pauli to develop a method—still widely influential—for regulating mathematical singularities in quantum field theory and extracting finite physical results. He moved to the United States in 1949, serving a year's term as a visiting member of the Institute for Advanced Study in Princeton, New Jersey. He began his MIT career as a research associate in 1950; he was appointed assistant professor in 1952, associate professor in 1955, and full professor in 1959. He served as chair of the Faculty from 1980 to 1983. He collaborated with Institute Professor Victor F. Weisskopf in studying the scattering of radio waves due to atmospheric turbulence, and with Institute Professor Herman Feshbach in studies of the effect of the earth's magnetic field on ionization in the atmosphere. Later in his career, he studied biology and applied rigorous mathematical analysis to elucidate the functioning of biological systems.

Manhattan Project alumnus and arms control advocate Victor F. Weisskopf, Institute Professor emeritus, died on April 21, 2002, at the age of 93. Born in Vienna, he received a PhD degree from the University of Göttingen in 1931. He served as a research associate at the University of Copenhagen, under Nils Bohr, and at the Institute of Technology in Zurich before coming to the United States in 1937 to teach at the University of Rochester. In 1943, he went to Los Alamos as a Manhattan Project group leader and associate head of the theory division on the exploitation of nuclear energy. He was appointed to the MIT faculty in 1945 but was granted a leave of absence to complete his work at Los Alamos; he arrived on campus a year later, as a full professor. After heading the theory group in MIT's Laboratory for Nuclear Science, he served from 1961 to 1965 as director-general of the European Center for Nuclear Research (CERN) in Geneva. He was named Institute Professor on his return from Geneva in 1966. From 1967 to 1973, he served as head of the Department of Physics and, in 1973, on the eve of his retirement, he was named the James R. Killian Award Lecturer. One of

the great figures in modern theoretical physics, Professor Weisskopf helped found the Federation of Atomic Scientists in 1944 and remained for the rest of his life an eloquent and effective proponent of arms control. He was awarded the National Medal of Science in 1980.

John M. Wynne, former vice president of the Institute, died on March 26, 2002, at the age of 81. Born in Kansas, he earned an AB from the University of Kansas in 1940 before beginning graduate studies at Stanford University. During World War II, he served as a Navy lieutenant in the Atlantic Fleet. He was a major in the Air Force during the Korean War and, as a civilian, worked for the Air Force in California while lecturing on industrial management at Sacramento State College. He received an SM in industrial management from MIT as a Sloan Fellow in 1956, returning to Sloan in 1958 as director of executive development programs. He was an associate dean from 1961 to 1967, when he was named vice president for organization systems. He served as MIT's vice president for administration and personnel from 1970 to 1980. After his retirement, he consulted on the redrafting of MIT's manual of policies and procedures, and joined the board of trustees of the Maharishi University of Management in Fairfield, Iowa, where he contributed to the development of that institution's MBA and PhD programs in management.

Statistics for the Year

Registration

In academic year 2001–2002, student enrollment was 10,204, compared with 10,090 in 2000–2001. There were 4,220 undergraduates (4,258 the previous year) and 5,984 graduate students (5,832 the previous year). The international student population was 2,589, representing 8 percent of the undergraduate and 37.5 percent of the graduate populations. These students were citizens of 109 countries. (Students with permanent residence status are included with US citizens.)

In AY2002, there were 3,457 women students (1,765 undergraduate and 1,692 graduate) at the Institute, compared with 3,335 (1,755 undergraduate and 1,580 graduate) in AY2001. In September 2001, 428 first-year women entered MIT, representing 41 percent of the freshman class of 1,033 students.

In AY2002, there were, as self-reported by students, 2,834 minority students (1,987 undergraduate and 847 graduate) at the Institute, compared with 2,780 (1,984 undergraduate and 796 graduate) in AY2001. Minority students included 382 African Americans (non-Hispanic), 97 Native Americans, 591 Hispanic Americans, and 1,764 Asian Americans. The first-year class entering in September 2001 included 498 minority students, representing 48 percent of the class.

Degrees Awarded

Degrees awarded by the Institute in AY2002 included 1,187 bachelor's degrees, 1,520 master's degrees, 10 engineer's degrees, and 501 doctoral degrees—a total of 3,218 (compared with 3,238 the previous year).

Student Financial Aid

During AY2002, 2,448 undergraduates received a total of $60,833,644 in student financial aid, exclusive of student employment and parent loans. This represents an increase of 6.25 percent in the number of grant and loan recipients and of 12.5 percent in total grants and students loans, reflecting the continuing downturn in the economy in the United States and abroad.

Total grant assistance to undergraduates was $52,013,220, an increase of 22.5 percent from the previous year, some of which is the result of improved data collection for private sources of grant aid. Seventy-five percent of this total grant assistance was from MIT sources, 9.5 percent from federal sources, and 15.5 percent from state and private sources. While MIT awards all its grants based on need, most private scholarships are awarded on merit or a combination of need and merit. Endowed scholarships and current gifts funded 92 percent of the MIT grants; the remaining 8 percent came from unrestricted funds.

Undergraduate students borrowed $8,820,424, a decrease of 24 percent from the previous year. This is the fifth consecutive year in which undergraduate borrowing decreased. Of the total loans made to undergraduates, $7,649,589, or 87 percent, came from federal sources, and the remaining 13 percent from MIT sources.

Graduate and professional students borrowed $22,067,204, an increase of 47 percent from the previous year. Of the total loans made to graduate and professional students, $11,336,543, or 51 percent, came from federal sources, 32 percent from private sources, and the remaining 17 percent from MIT sources. The significant increase in graduate and professional student borrowing is attributable to the CitiAssist Loan program for the Sloan School of Management.

Career Services and Preprofessional Advising

Fears of a devastated job market were not reflected in on-campus recruiting during AY2002. While the numbers were down 31 percent from the preceding year, almost 400 companies participated in InterviewTrak, the web-based employment recruiting program of the Office of Career Services and Preprofessional Advising (OCSPA). There were 13,156 users registered with the program, including 7,252 undergraduates, 3,681 master's candidates, 168 MBA candidates, 1,844 doctoral candidates and 211 postdocs. OCSPA coordinated over 1,000 schedules resulting in more than 6,000 interviews. Largely due to travel restrictions and budget cuts, some employers chose not to come to MIT. Instead they used the online system to review candidates' resumes and then conducted first-round interviews by telephone, following up with plant trips in the second round.

Consulting and finance firms made up over a quarter (26.7 percent) of the AY2002 on-campus recruiting program. Software and Internet firms accounted for 16.5 percent; materials, oil, chemical, and food employers, 6.7 percent; biomedical device and pharmaceutical firms, 5.8 percent; and information systems consulting firms, 2.9 percent. A variety of other employer types, including civilian electronics, federally funded laboratories, and design, construction, and engineering services, comprised the remaining 41.4 percent. Engineering salary offers typically ranged from $49,000 to $58,000 for bachelor's candidates, $60,000 to $75,000 for master's candidates, and $71,000 to $91,000 for doctoral candidates.

In 2001, there were 123 MIT applicants to medical school—6 graduate students, 54 undergraduates and 63 alumni/ae. Acceptance rates were 100 percent for graduate students, 65 percent for undergraduates, and 70 percent for alumni/ae. (The national acceptance rate for all

applicants was 50 percent.) The average GPA of accepted undergraduates was 3.74/4.0.

Private Support

Private support for fiscal year 2002 totaled $222.9 million and included $214.7 million in gifts, grants, and bequests, and $8.2 million in support through membership in the Industrial Liaison Program. The total compares with $200.8 million in 2001, $233.6 million in 2000, $209 million in 1999, and $143.9 million in 1998. Gifts-in-kind for the past year (principally gifts of equipment) were valued at $5.7 million.

By source, gifts from alumni/ae totaled $76.3 million; non-alumni friends, $14.3 million; corporations, corporate foundations, and trade associations, $48.8 million; foundations, charitable trusts, and other charitable organizations, $66.7 million; and others, $8.6 million.

Finances

Unrestricted revenues available for operations for FY2002 totaled $1.59 billion, and total operating expenses were $1.54 billion. Net assets decreased $0.8 billion, totaling $7.1 billion at year-end. The market value of the MIT endowment at year-end was $5.5 billion, $0.8 billion lower than the previous year.

The research revenues of departmental and interdepartmental laboratories, primarily on campus, totaled $419.1 million in FY2002, an increase of 4.5 percent from the previous year. Industrial sponsors as a group remained the largest source of sponsored funds at MIT, followed by the National Institutes of Health and the Department of Defense. Lincoln Laboratory reported revenues of $392.1 million, an increase of 10.4 percent from last year's $355.2 million.

Facilities and Campus Environment

Academic year 2001–2002 was probably the busiest and most challenging the Department of Facilities has faced in decades. The remarkable level of activity reflected unprecedented capital construction, numerous renovations and space changes, and the Institute's ongoing response to the dangers of terrorism.

During the year, work continued on many major construction projects:

- Interior fit-out design on the Ray and Maria Stata Center for Computer, Information, and Intelligence Sciences neared completion. The 10-story Dreyfoos and Gates towers were topped off in June 2002, and brick veneer work to the exterior of the building began. The garage is expected to open in the spring of 2003 and the entire project should be completed in November 2003.
- The 10-story structure of Simmons Hall was completed. The exterior metal skin and windows were nearly finished, and interior fit-out for floors 2 through 10 was almost complete. Students were expected to move into the residence hall in August 2002, although the first-floor dining area and community spaces would not be finished until November.
- Structural steel work for the Albert and Barrie Zesiger Sports and Fitness Center was completed in August 2001. The exterior skin of the building followed, and it was fully weather-tight in June 2002. By the end of the academic year, interior fit-out was nearly complete. Occupancy was expected at the beginning of the academic year.
- Graduate students moved into the efficiency apartment-style units at 224 Albany Street—a converted industrial building—in August 2001.
- As the academic year came to a close, construction was almost complete at 70 Pacific Street. This new residence hall, which will house approximately 750 students, was scheduled to open in August 2002.
- The Vassar Street utilities project is well underway. Utilities for Simmons Hall were finished in June 2002, and steam line work for the Zesiger Sports and Fitness Center was expected to be completed in mid-August. The fire line service and chilled water lines were piped into the Stata Center, with the steam line expected to finish in mid-July.
- The first phase of the renovation of the Dreyfus Chemistry Building was completed in June 2002. During this infrastructure renewal project, all laboratories, support, and office spaces will be renovated in vertical phases from one end of the building to the other while the building is two-thirds occupied. Completion is expected in the summer of 2003.
- The design for the Media Lab Extension was completed in June 2002.
- The Brain and Cognitive Sciences Center is in the design development phase, and site construction is expected to start next spring.
- The design for the east side of the Vassar streetscape (between Main Street and Massachusetts Avenue) was completed and went out for bid in June 2002. The start of the west side phase of the project (from Massachusetts Avenue to Audrey Street) will be delayed because of major city and state projects planned for the same area.

The Design and Construction Services group within the Department of Facilities undertook a variety of significant renovation projects, in addition to completing 95 space

changes throughout the Institute. Project highlights included the initial phase of renovating Lobby 7, involving masonry restoration, floor cleaning, and major work on the skylight, which was lit for the first time since the World War II blackout; a new entrance and facade for The MIT Museum; and renovations in Building 26 to house the Technology Enabled Active Learning initiative in the Department of Physics.

Other major changes included renovations to the second floor of Building 3, equipping lecture hall 3-270 with state-of-the-art distance learning capabilities, and adding the George and Daphne Hatsopoulos Microfluids Laboratory on the entire west side of the floor; and renovations to the sub-basement of Building 66, the sixth floor of Building 37, and the fourth floor of Building N52.

Off campus, the first phase of a renovation and expansion program was completed at Endicott House in Dedham. The changes increased the amenities and the capacity of the kitchen facilities, upgraded life-safety systems, and improved access to the mansion.

Since the terrorist attacks of September 11, administrative leaders and staff from across the Institute have collaborated on efforts to ensure that the campus is secure while maintaining the level of openness appropriate and necessary for an academic community. Staff in many administrative areas—including notably the Campus Police, Environmental Programs and Risk Management, the Department of Facilities, and Information Systems—played critical roles in the Task Force on Campus Security and related initiatives. A new Security Operations Team has prioritized security tasks and is responsible for their implementation: enhancements have been made in access and communications systems, campus lighting and patrols, operational procedures and protocols, and training.

Office of Government and Community Relations

The Office of Government and Community Relations (OGCR) is the Institute's primary liaison with city/town and state government. The office also supports the mission of the MIT Washington Office to reinforce the efforts of the president, faculty, and administrators in their contacts with the federal government and several national higher education associations. The principal focus of OGCR is the Cambridge/MIT relationship. OGCR endeavors to promote understanding between Cambridge residents, neighborhood organizations, elected officials, businesses, and MIT in order to develop constructive working relationships, nurture partnership efforts, and collaborate on matters of mutual concern.

Local Government Relations

This year, OGCR provided background and guidance on various licensing, permitting, zoning, taxation, safety, and transportation processes and issues in Cambridge and in other towns. The office led the effort to prepare the Institute's annual Town-Gown Report and the subsequent presentation to the Cambridge Planning Board. OGCR monitored the establishment and launch of the Cambridge City Council's new permanent Committee on University Relations and prepared for several meetings between the committee and MIT staff, including one large-scale public session with MIT senior officers.

Federal Government Relations

OGCR supported President Vest's monthly visits to Washington, D.C., by preparing background material and establishing the itinerary for various meetings with members of the executive and legislative branches of the federal government. The office represented MIT on several committees of national associations focusing on community service, work-study financial aid, and other educational topics. The office continued its annual practice of managing the president's mailing to the members of Congress providing each with the names of freshmen admitted to the Institute from his or her state. The office has continued to advance MIT's productive relationship with regional Environmental Protection Agency officials as the Institute and the EPA work on improving the water quality of the Charles River. Toward this end, MIT hosted and sponsored a competition to uncover creative ideas in storm water management.

Community Relations

The office worked closely with the Cambridge public school system, the MIT Public Service Center, the MIT Museum, the Edgerton Center, and others to carry out a wide variety of educational programs and initiatives on behalf of Cambridge school children. The office's activities included hosting the Academic Year Kickoff Program for all 1,000 Cambridge schoolteachers and administering the donation of a video production studio to Cambridge Rindge and Latin High School. OGCR managed MIT's hosting of the Massachusetts State Science Fair and assisted in the planning of the Elementary School Science Expo. The office also collaborated with neighborhoods adjacent to the MIT campus in order to enhance educational and after-school activities for residents.

Office staff accommodated dozens of community-based facility use requests such as providing a venue for the Community Art Center's teen film festival and hosting a conference for the Cambridge Office of Workforce Development. OGCR also managed the Institute's response to a multitude of "constituent service" inquiries and requests. Staff represented MIT on more than 20 nonprofit boards and committees.

The office hosted the 10th annual Cambridge First Day at MIT celebration, honoring agencies providing services to homeless individuals. OGCR also hosted the 8th annual President's Community Service Awards program, honoring an MIT and a Cambridge volunteer for exemplary community service. The office participated in a panel discussion on Cambridge town-gown relations sponsored and aired by Cambridge Community Television.

Community Service Fund

This year, the 34-year old Community Service Fund—which supports the efforts of MIT volunteers in the community—was integrated with the Institute's overall community giving campaign. As a result, contributions to the CSF increased and the office oversaw the disbursement of $90,000 from the fund to local nonprofit organizations.

Sarah E. Gallop, Co-Director
Paul Parravano, Co-Director

More information on the Office of Government and Community Relations can be found on the web http://web.mit.edu/govt-relations/www/.

Ombuds Office

The MIT Ombuds Office serves as a neutral, confidential, independent, and informal resource to the MIT community for resolving disputes, managing conflict, and for educating individuals in more productive ways of communicating. The office advocates for a fair conflict management system and supports systemic changes to achieve this goal.

During the past academic year, the Ombuds Office undertook a review of its operations and effectiveness and developed an operations plan. The plan seeks to improve the effectiveness of the Ombuds Office in delivering services to the MIT community, to foster an effective MIT conflict management system in collaboration with the other elements of the system, and to help improve the skills of supervisors and managers in preventing unnecessary conflict at the local level.

The Ombuds Office received more than 1,200 people in academic year 2001-2002, including faculty, students and staff. Common issues included academic concerns, conditions of work and study, performance and supervision, policies and procedures, personal and interpersonal concerns, concerns about various perceived transgressions, separations and terminations from MIT, requests for referrals, and consultations about how to deal with a specific concern.

The office continued to work in collaboration with various academic and administrative departments in reviewing, improving, and better coordinating the Institute's internal administrative conflict management policies and procedures. The office is continuing to improve its website, and is searching for ways to improve access to information about the office and about other resources in the MIT conflict management system.

Ombuds staff designed and taught a course for several groups of faculty and high-level administrators on MIT's complaint handling processes and how to improve complaint handling skills. Several shorter versions of the course are occasionally offered as well. After September 11, Ombuds staff facilitated group and individual discussions focused on painful issues between the Israeli and Arab communities.

Externally, Ombuds staff designed and delivered training, and participated in panel discussions about the role of an organizational ombuds in North America—through The Ombudsman Association and the University and College Ombuds Association, and as invited speakers elsewhere. These sessions focused on ways that an ombuds program may enhance the effectiveness of an organization—by providing a means for individuals to raise and resolve issues early on, and reduce the number and cost of contentious complaints. Several sessions concentrated on dealing effectively with harassment and discrimination by taking a systems approach within an organization and one focused on "new problems turning up in organizations." Ombuds staff continue to survey ombudspeople worldwide, participate in professional conference calls, and write articles—most of them available on the Ombuds website.

Since the departure of Thomas P. Zgambo from the Institute in June 2001, there have been two ombuds on staff; during AY2002 a search was underway for a third ombuds.

Toni Robinson, Ombudsperson
Mary P. Rowe, Ombudsperson and Special Assistant to the President

More information about the Ombuds Office can be found on the web at http://web.mit.edu/ombud/.

MIT Washington Office

The president established the MIT Washington Office within his office during the spring and summer of 1991. The office opened on August 12, 1991. The vice president for federal relations heads the office and reports to the president. The staff includes assistant director Suzy Glucksman and staff associate Kathryn Alsbrooks.

Mission

The mission of the Washington Office is to support the advocacy activities of the president in Washington and to represent the Institute in Washington as one of the nation's premier academic institutions. The office maintains a steady flow of information between MIT and the federal government. Staff members gather and disseminate information to the MIT campus concerning government activities and actions. The staff also makes the university's resources available to federal officials, facilitating the sharing of them with Congress, the Executive Branch, and other national organizations. The office maintains liaison with the offices of the Massachusetts congressional delegation and other congressional offices.

Advocacy Coalitions and Working Groups

The vice president and staff are engaged in the activities of the major organizations and coalitions that work in support of the federal investment in university research and education, including the following:

The Science Coalition*

The Council on Competitiveness (COC)

The COC Committee on Federal Relations

The Association of American Universities (AAU)

The AAU Council on Federal Relations

The National Association of State Universities and Land-Grant Colleges (NASULGC)

The NASULGC Council on Government Affairs

The Council on Government Relations

The Coalition for National Science Funding*

The Coalition for National Security Research*

The Energy Sciences Working Group*

Coalition for Plasma Science*

Nuclear Energy Day*

The Science, Engineering and Technology Working Group

The AAU Space Sciences Working Group

Space Grant Day*

Jefferson Day of the National Humanities Alliance*

The office frequently engages MIT faculty and students as advocates with members of Congress and their staffs. This year, eight faculty members, two administrators, and four students participated in advocacy events sponsored by those groups noted with an asterisk (*).

Post-September 11 Legislative Initiatives

Following the terrorist attacks of September 11, 2001, the vice president collaborated with colleagues in national organizations as the university community responded to a series of national legislative and policy proposals that sought to strengthen homeland security. These activities dominated much of the year. The work, which began with efforts to counter proposals to freeze the flow of foreign students into the United States, rapidly evolved into efforts to secure prompt, workable implementation of the Student and Exchange Visitor Information System (SEVIS). Three statutes were enacted, each of which imposes new, acceptable, requirements on research universities. For several months, the vice president engaged senior MIT administrators in activities related to these bills and related matters. Notable contributions to the work of national organizations and to the policy outcomes were made by vice president for research Alice P. Gast, senior counsel Jamie Lewis Keith, director of the Office of Sponsored Research Julie T. Norris, and director Danielle Guichard-Ashbrook and the staff of the International Scholars Office. Working collaboratively as a team, MIT officials helped to secure acceptable policy and legislative outcomes.

MIT Lincoln Laboratory, Center for Fusion and Plasma Science, Bates Laboratory

MIT Lincoln Laboratory, the Center for Fusion and Plasma Science, and Bates Laboratory are among MIT's largest research entities. In terms of federal research support, they are among the most vulnerable to abrupt shifts in funding priorities. The vice president continued to accompany the associate director of Lincoln Laboratory on visits to key congressional offices. The objectives were to brief key staff on current activities and accomplishments of the laboratory, and, at the end of the congressional cycle, to express appreciation for the continued support of key members and staff. The assistant director performed the same function intensively for the Center for Fusion and Plasma Science and the Bates Laboratory.

MIT Congressional Staff Seminar on Science and Technology

In 1993, with the financial support of the Sloan Foundation, MIT began an annual seminar for senior congressional staff on science and technology issues. The president invites more than 200 staff leaders of key committees and related policy groups to attend an intensive two-day seminar with senior MIT faculty and presenters from industry and other

universities. In 1993, the first attendees established the format. Topics are suggested by staff. Professors Eugene B. Skolnikoff, Claude R. Canizares (now associate provost), and Stephen Ansolabhere are co-directors of the program. On April 3-5, 2002, 20 senior staff attended the seventh seminar—"Energy: Technology and Policy Choices." Professor Ernest J. Moniz chaired the planning committee. The Washington Office again identified invitees, made travel arrangements and served as program staff throughout the seminar. Senior career staff of the Executive Office of the President approached the vice president to express interest in participating in future seminars.

Executive Branch

The vice president began to accompany the associate provost on visits to senior officials of Executive Branch agencies with responsibilities for science and technology, beginning with the National Aeronautics and Space Administration and the National Science Foundation. Future, more frequent visits are planned to the Department of Defense and the Defense Advanced Research Projects Agency, the Department of Energy, and additional agencies.

John C. Crowley
Vice President for Federal Relations

More information about the MIT Washington Office can be found on the web at http://web.mit.edu/dc/.

Provost

The tragic events of September 11, 2001 caused academic year 2002 to be especially difficult for all at MIT. The sense of loss and uncertainty caused by the terrorist attacks and the changes in all of our lives that began unfolding throughout the year made progress towards our goals more challenging. Even so there were significant advances in the academic and educational programs and initiatives of MIT. Some of these advances are highlighted in this summary. Others are described in the reports of programs, departments and schools, which follow.

People

There were significant changes in the Academic Council in 2002. Chancellor Larry Bacow left MIT to become president of Tufts University. President Charles Vest appointed Professor Phillip Clay, who had served MIT as associate provost since 1994, to the chancellor position. Chancellor Clay brings a wealth of experience working with our faculty and students to his new position. Chancellor Clay has responsibility for the offices of the deans of undergraduate education, student life, of graduate students, and for coordination of MIT's corporate and academic institutional partnerships.

With Professor Clay's change in responsibilities, the Provost's Office was reorganized to include two faculty serving in the role of associate provost. Professor Claude Canizares, Bruno B. Rossi professor of physics and previously director of the Center for Space Research, became associate provost in fall of 2001. In this role Professor Canizares will work with faculty issues and will serve as chair of the Committee on the Review of Space Planning. In this role he will oversee the reallocation of space and space renovation. Professor Canizares will also assist President Vest in advising federal departments and agencies on issues that face American research universities.

Professor Alice P. Gast, Robert T. Haslam professor of chemical engineering, joined MIT in November 2001 as the vice president for research and associate provost. Professor Gast will have responsibility for fostering and oversight of large inter-disciplinary research initiatives, including centers and laboratories, in addition to the traditional role of the vice president for research in setting policies in research and graduate education.

Stephen C. Graves, Abraham Siegal professor of management of the Sloan School of Management, completed his first year of the two-year term as chair of the MIT Faculty. Rafael Bras, Stockholm-Bacardi professor of civil and environmental engineering, was named chair-elect of the faculty.

There were changes in the rank of Institute Professor during the academic year. Noam Chomsky, Institute Professor of linguistics, retired at the beginning of the calendar year. Emilio Bizzi, Eugene McDermott professor of brain and cognitive sciences and member of the McGovern Institute, was named an Institute Professor in the spring of 2002. We must also note the sad passing of Institute Professor emeritus Walter Rosenblith in May 2002.

Reports to the Faculty

In the fall of 2001 the provost and the chair of the faculty established the Ad Hoc Committee on Access and Disclosure of Scientific Information to examine the relationship between the openness of research on our campus and the values of the faculty and the Institute. The committee was chaired by Institute Professor Sheila Widnall and included Professors Vincent Chan, Harvey Sapolsky, Jerome Friedman and Stephen Graves. The committee was asked to determine if our current policies provide adequate guidance to consider MIT's role in classified research in the context of the 21st century. Specifically, the committee was asked to address the following issues:

1. Does the policy, as stated by Section 14.2 of Policies and Procedures, give the appropriate context for considering classified research on campus?
2. While the policy differentiates between classified research at MIT Lincoln Laboratory and on campus, what are the implications of faculty and graduate student participation in research projects being conducted at Lincoln Laboratory when the research has a classified component? Are there conditions under which such research is acceptable?
3. Section 14.2 of Policies and Procedures is specifically silent on the use of classified material on campus, as opposed to carrying out classified research. How should we interpret our policy with respect to the use of classified material on campus?
4. As the industrial research base of MIT expands, issues can arise concerning the openness of this research on campus. How do our policies for dealing with this research, as agreed upon in research contracts and as practiced, comply with the values of the academic community?

The committee's report, *In the Public Interest*, was published in May 2002 and is available from the Provost's Office and at http://web.mit.edu/faculty/reports/publicinterest.pdf.

The report reaffirms the commitment of the faculty to an open research community in which scholarly inquiry and education are not blocked by obstacles created by constraints of disclosure and publication created either by the government or industry sponsors. The report reaffirms our belief in the need for a rigorous federal definition of classified research and that this type of research should

be carried out at secure research laboratories, not on our campus. The report supports MIT's important role in operating Lincoln Laboratory for the federal government as a secure research facility staffed by researchers, but not by faculty and research students. The ad hoc committee recommended the formation of a standing committee of the faculty to monitor research policy changes within MIT. The provost and the vice president for research will establish such a committee in academic year 2003.

Academic Programmatic Initiatives

Facilities

The Institute is continuing an aggressive campaign of new construction and renovation aimed at renewal of our campus environment. New space is being added for student housing and activities. New academic program space is being constructed for information sciences, neurosciences, and inter-disciplinary research and educational initiatives.

Construction continued on the Ray and Maria Stata Center, which, will be the home of the Laboratory of Computer Science, the Artificial Intelligence Laboratory, the Laboratory for Information and Decision Systems, and the Department of Linguistics and Philosophy. The Stata Center will also house a major childcare facility, teaching facilities, and significant social space for students, staff, and faculty. The architect Fumihiko Maki completed design on the expansion of the Media Laboratory. The building will be located adjacent to the Wiesner Building at the corner of Ames and Amherst streets. The demolition of Building E10 also was completed to clear this site. Construction will begin once external sources for funding are identified to complete the project.

By the end of FY2002 the construction moved to the final stages on two new major student residences. Simmons Hall, an undergraduate residence, designed by Steven Holl, will open in September 2002 on Vassar Street. Construction also is almost complete of the new graduate residence at Sydney and Pacific, which will house over 700 students. This facility also is scheduled for completion in fall 2002.

Construction also was finishing on the Albert and Barrie Zesiger Sports and Fitness Center as part of the athletic complex. The Zesiger Center will house an Olympic-sized swimming pool, diving facilities, and a fitness center. It is scheduled for completion in August 2002.

Program developments, site planning, and preliminary design work also have begun on the Brain and Cognitive Science Center, which will house the McGovern Institute for Brain Research, the Picower Center for Learning and Memory, and the Department of Brain and Cognitive Science. It is anticipated that this center will have approximately 200,000 net assignable square feet and will be an integrated facility for neuroscience research on campus. Construction is scheduled to begin in spring of 2002 with completion in 2005.

The process for site selection and for establishing the program for a new facility for the Sloan School of Management also was continued in 2001, working with the architectural firm of Moore, Ruble and Yudell. The report of their findings is expected in late summer of 2002 and will be the basis for defining the site program and funding goals for the project.

The Institute remained committed to an aggressive plan for renovation of physical facilities. The process for prioritizing and planning space renovations was led by Associate Provost Claude Canizares as chair of the Committee for Review of Space Planning (CRSP). Other members of CRSP include the provost, the executive vice president, the chancellor, the vice president for research and associate provost, the chief facilities officer, assistant to the provost for space planning, the director of capital project development, the director of design and construction, and the staff liaison in the Department of Facilities. In FY2002 MIT allocated over $24 million in funds for this purpose, including department and philanthropic contributions; $68.6 million was spent on renovations in FY2002. Several major renovations were carried out in AY2001. These include the continued, staged renovation of the Dreyfus Chemistry Building, Building 18. The many other renovation projects that were completed included the undergraduate teaching laboratories for the Department of Chemical Engineering, the George and Daphne Hatsopoulos Laboratories in the Department of Mechanical Engineering, and ten classrooms in Buildings 1, 4, 5, and 36.

New initiatives driven by interdisciplinary research and education programs also increased the need for research space. The new Institute for Soldier Nanotechnology (ISN) awarded to MIT by the United States Army Research Office requires shared space for interdisciplinary efforts. This 30,000 sf facility is being planned to be leased in 500 Technology Square, as two floors of this building. In addition, the growth of the Division of Biological Engineering (BED) also was accommodated by leasing an additional two floors of this building.

The growth of the McGovern Institute for Brain Research and the Picower Center for Learning and Memory in advance of the completion of the new neuroscience center in 2005 is being made possible by relocating administrative units from E19 to lease space in 600 Technology Square and renovating approximately 16,000 nasf of E19 for laboratory use. These changes will occur in FY2003.

Planning for these projects has been greatly aided by the work of the Olin Partnership on the creation of a framework for the development of the MIT campus. This process began in 1999 and was completed in fall 2001.

Faculty and Academic Programs

At the end of academic year 2002, 13 faculty members retired from MIT.

Faculty recruitment continued at a vigorous level. In academic year 2002, 50 faculty were hired at untenured ranks and 10 tenured faculty were recruited. Of these (tenured and untenured) 20 are women and five are minorities. During 2002, 20 MIT faculty members were awarded tenure within MIT. Of these, four were women and four were under-represented minorities.

Renewed emphasis on the importance of improving the gender and racial diversity of the faculty began with the formation of the Council on Faculty Diversity in the fall of 2001. The council is co-chaired by Professor Nancy Hopkins, of the Department of Biology, Professor Wesley Harris and Provost Robert Brown and includes faculty and administrative leaders from the five schools of MIT. The council's mission is to work with the faculty, departments, schools and the senior administration to help the Institute aggressively promote faculty diversity. These efforts will work to establish a sustained institutional environment that will attract a diverse faculty that reflects the students we educate. The council will work to enhance both racial and gender diversity of the faculty by considering all aspects of faculty development:

- Understand the pipeline of women and minority students through undergraduate and graduate schools, to postdoctoral associate positions and finally to a faculty position. Design programs and policies to enhance retention in the pipeline.
- Examine policies and processes for faculty hiring within MIT. Make recommendations on how to more effectively enhance faculty searches and recruitment of women and minorities candidates.
- Create programs and policies that are sensitive to the need to balance an academic career with a family life.
- Establish an open and inclusive environment for a diverse faculty that promotes involvement in leadership throughout MIT.

Two important initiatives of the Council on Faculty Diversity were implemented in 2002. First, the provost issued new guidelines for faculty searches. These guidelines include procedures for each school to establish oversight of search processes for aggressive recruitment of women and under-represented minorities for open positions and for review of applications from these groups. Each school established a slightly different process for achieving these objectives; the deans of the five schools play a crucial roe in leading these processes and driving faculty recruiting. Remarkable success resulted in the faculty recruitments in AY2002 in the School of Engineering; five of 21 hires were women. The Council on Faculty Diversity will analyze the practices of individual departments and schools and help guide the optimization of future faculty recruitment.

The Council on Faculty Diversity also spearheaded changes in faculty leave and tenure policies for child-bearing and child raising. These policies give an extension of the probationary period for a woman faculty member who bears a child and for part-time faculty appointments for faculty members who wish to devote significant time to raising children. These policy changes are summarized in my February 21, 2002 memo to deans and department heads and they have been incorporated into Policies and Procedures.

MIT continued its commitment to enhancing the diversity of the teaching staff of the Institute through the Dr. Martin Luther King Jr. Visiting Professor Program. There were six visiting faculty sponsored by this program during the academic year. The visitors and their departments were Edna Ambundo, Chemistry; Otis Jennings, Sloan School of Management; Raul Lejano, Department of Urban Studies and Planning; Sekazi Mtingwa, Physics; Eni Njoku, Civil and Environmental Engineering; and Phillip Thompson, Department of Urban Studies and Planning.

Five new Margaret MacVicar Faculty Fellows were named this year in recognition of their important contributions to the quality of undergraduate education at MIT. These awardees are Alan Guth, Physics; Steven Hall, Aeronautics and Astronautics; Kip Hodges, Earth, Atmospheric and Planetary Sciences; Nancy Kanwisher, Brain and Cognitive Sciences; and David Thorburn, Literature.

In AY2002 the Presidential Graduate Fellowship program awarded 167.5 fellowships across all MIT academic departments. These fellowships are distributed as follows, and include fellowships named for several individual and corporate donors—Robert T. Haslam (Chemistry and Chemical Engineering), William M. Layson (Physics), Akamai (Mathematics and EECS), and Praecis (Biology):

Architecture and Planning	12.5
Engineering	56
Humanities	20
Sloan School	15
Science	57
VP Research	7
Total	**167.5**

In addition, five students hold Provost's Women and Minority Fellowships (one in each school) and five minority graduate students hold Norman B. Leventhal Presidential Graduate Fellowships (three in Engineering and two in Science). The Society of Presidential Fellows hosted several events during the academic year including beginning and end-of-year receptions, and well-attended public lectures by Professor Eric Lander, director of the Whitehead-MIT

Human Genome Center and Professor Robert Langer of the Department of Chemical Engineering.

Finances

Fiscal year 2002 represented the completion of the budgetary cycle begun with planning in fall of 2000, and marked the third year of implementation of the new process of budget approval by the Executive Committee of the Corporation. The fiscal year financial performance was on budget, closing with a small (approximately $7.4M) surplus excluding funds used to established reserve accounts in several areas. This budget included funds for the renovation program, less income from graduate tuition charged to research associates, and funding of the Presidential Graduate Fellowship Program.

The performance of the FY2002 budget continued to benefit from the robust growth of the sponsored research base on campus. The research base bearing indirect costs (the MTDC base) grew 7.7 percent in FY2002, marking the third year of significant growth in on-campus research volume. Tuition revenue, net of financial aid rose two percent or $3.1M in FY2002, influenced most greatly by the increase in financial aid. Net tuition revenue showed an increase of 3.2 percent or $4.5M over budget, influenced most greatly by the increase in the number of graduate students at MIT to 5,984 in fall of 2001.

The financing of operations continued to rely heavily on income generated by the Institute's endowment. The endowment began FY2002 at $6.1 billion down from approximately $6.5 billion in 2001. The final returns for fiscal year 2001 reflect an almost 10 percent decrease in market value to $5.4 billion. The decrease of the endowment and the forecasts for lack of growth in FY2003 will have significant long-term impacts on the MIT budget. The downturn in the market value of the endowment, coupled with the 36-month trailing average of the value of the endowment for the purpose of computing the distribution of income, will likely lead to decreased income from the endowment in future years. The ramification on general institute budgets will be felt in fiscal year 2004 and beyond.

Planning and budgeting will continue to rely more heavily on the uses of the income from both restricted and unrestricted endowment in the operations of the Institute. All funds accounting was implemented during the FY2002 budget cycle in recognition of this increasing role. We anticipate that decisions in the annual budget cycle will be based more on this information in FY2003 and in the future.

The MIT capital campaign, which was launched in FY2000 to raise $1.5 billion in endowment and expendable gifts progressed well in FY2002. The campaign, which is scheduled to run through 2004, closed this year with approximately $1.46B toward the $1.5B goal. Approximately $263M was added toward this total in FY2002.

Education

MIT continued with its momentum in new educational initiatives supported by several sources, including the fund established by Brit and Alex d'Arbeloff and the Microsoft I-campus project. Both of these initiatives have been organized through the MIT Council on Educational Technology (MITCET), which was established to advise the senior administration on strategic issues involving information technology and to help select major initiatives and monitor progress. The council is co-chaired by Hal Abelson, professor of the Electrical Engineering and Computer Science Department, Robert Redwine, professor of physics and dean of undergraduate education, and Provost Robert Brown.

A major initiative of MITCET was the establishment of OpenCourseWare@MIT (OCW) as a web site for MIT subjects. It will include the course content (syllabus, lecture and recitation notes, assignments and solutions) for essentially all MIT subjects and be opened to everyone outside MIT. The OCW concept was supported by the faculty and endorsed by the administration. Initial support for OCW has been found from the Andrew W. Mellon Foundation and the William and Flora Hewlett Foundation. The OCW organization was launched in academic year 2002 under the direction of an Interim Management Group chaired by Professor Steve Lerman of the Department of Civil and Environmental Engineering. Ann Margulies joined MIT in May 2002 to lead OCW. The first launch of the web site is planned for September 2002.

MIT continued to develop distance education initiatives as institution-to-institution partnerships. In the fall of 2001, the Singapore/MIT Alliance—the partnership between MIT and the two major universities in Singapore, National University of Singapore and Nanyang Technological University—expanded to include five master's and doctoral level programs. These programs are in advanced materials for micro and nano systems, high-performance computation for engineered systems, innovation in manufacturing systems and technology, molecular engineering of biological and chemical systems, and computer science. The programs are co-taught by MIT and Singapore faculty, with most of the MIT teaching being delivered by a combination of synchronous and asynchronous communications technology.

The programs for the collaboration between MIT and Cambridge University of England called the Cambridge-MIT Institute continued to develop. The number of exchange students between MIT and Cambridge University grew in AY2002: 27 MIT undergraduates attended Cambridge University, and 32 Cambridge University undergraduates attended MIT.

Research

MIT remains the preeminent research university combining world-leading research across a spectrum of disciplines with intense undergraduate and graduate education. Efforts in FY2002 have continued to focus on securing increased federal support of research and increasing research support from corporations, foundations and international sources to diversify the support of our programs. These efforts began to impact the research volume of MIT in FY2002.

There was a healthy increase in all sponsored research on campus, which was up 10 percent to $448M in FY2002 from $407M in 2001. More importantly, the portion of this research volume bearing financial and administrative (F&A) costs rose 7.7 percent in FY2002 to $227M. The federal government continued to dominate this budget, accounting for approximately $333M or 74 percent. However, non-government support rose to $115M or 26 percent. The Lincoln Laboratory research volume in FY2002 was $392M, up from FY2001 at $355M.

The growth of the research volume was wide-spread across most of science and engineering and was net of significant decrease in research support in the Media Laboratory in the School of Architecture and Planning where research decreased from $25M in FY2001 to $18M in FY2002.

This report marks the completion of my fourth year as provost.

Robert A. Brown
Provost
Warren K. Lewis Professor of Chemical Engineering

Center for Advanced Educational Services

The Center for Advanced Educational Services (CAES) is an organization that focuses on research, development, and delivery of technology-facilitated education. CAES designs and conducts experiments in technology-enabled learning, often resulting in educational products for the wider community. During fiscal year 2002, the center created and distributed MIT educational offerings through academic programs available on campus, designed to help professionals keep pace with developments in their field. The center staff also worked collaboratively with MIT schools and departments to provide distance-learning credit courses for professionals and lifelong learners.

CAES develops asynchronous teaching and learning through online web tutors, videotapes, videostreaming, and CDs, and encourages collaborative learning through interactivity and feedback. Outreach beyond the MIT campus is one of the core objectives of CAES. Working closely with MIT's Academic Media Production Services and Web Communications Services, CAES is engaged in external initiatives in the development and application of educational technology.

CAES has increasingly focused on disseminating its knowledge globally, particularly to developing countries through distance learning and a new partnership with the African Virtual University. Two interactive web sites and a new videostreaming web site, MIT World, are designed for the world to have free access and show the intellectual content of MIT disseminated through educational technology. Further information can be found at http://www-caes.mit.edu/index.html.

Accomplishments

MIT World

September 2001 saw the official launch of MIT World (http://web.mit.edu/mitworld), MIT's free, open video streaming web site that provides videos of significant public events at MIT. One of the most successful projects of CAES, MIT World follows a model similar to OpenCourseWare in bringing content to global audiences. Intellectual content from MIT can now be seen from anywhere in the world—or indeed by anyone with a computer, Internet access, and RealVideo player.

MIT World worked closely with its two internal partners, the MIT Alumni Association and the Industrial Liaison Program in matters of policy, content selection, and methods for measurement. Systems were put in place with MIT Video Productions for acquiring video taping services, and with MIT's Streaming Media and Compression Services to streamline the processes for digitizing the videos, and to purchase a video server. MIT World worked with Educational Media Creation Center staff to redesign the site and create a new logo.

MIT World also partnered with Web Communications Services to find efficiencies in the web production model to facilitate frequent updating of the site. This collaboration has resulted in an efficient operating model and significant cost savings over original plans. Once the operational issues were resolved, WCS provided access to extremely affordable and meaningful measurement tools that enabled MIT World to show that this site was indeed becoming increasingly valuable to the audience. These tools were in place as MIT World was spotlighted on the MIT home page. Traffic on the site increased ten-fold during the three-day period of the spotlight in May 2002.

In year one, MIT World presented 60 videos representing a wide range of content from 18 separate schools/departments/centers at MIT and 75 public events. They include The Resilient City series; authors@MIT, Ford/MIT Nobel Laureate Lecture Series, Technology and Culture Forum, Electrical Engineering and Computer Science Colloquia series, Center for International Studies, School of Engineering, Alumni Association Tech Day, and Industrial Liaison Program.

Early results from the measurement tools show significant use of the site 24/7. Web traffic is growing at a rate of 20 percent per month; on average 90–100 videos are being watched per day; and 72 percent of the traffic comes from the US. The top ten counties (after the US) are Canada, Great Britain, China, Germany, Republic of Korea, Japan, India, Singapore, Australia and Taiwan. To date more than 300 users have asked to be on the mailing list for updates. Approximately 30 percent of the feedback is from MIT Alumni.

The three most popular videos are Lester Thurow, "Globalization and the Economic Downturn"; Wolfgang Ketterle, "The Coldest Matter in the Universe"; and Robert Langer, "Biomaterials and How They Will Change Our Lives."

Information about MIT World is well integrated into many communication vehicles at MIT, including Fast Facts from Resource Development, News Office Digests, Alumni Association newsletters and ILP marketing materials. MIT World has also become an inaugural partner with WGBH for its Network Forum, a free streaming video web site that gathers material from educational and cultural institutions in the greater Boston/Cambridge area. This partnership will provide exposure from the WGBH site, as well as promotional opportunities on WGBH's three television and two radio stations, as well as print communication to its local members.

MIT World has met its first-year goals and is fast becoming an essential intellectual offering of MIT. It has quickly become woven into the broader fab ric of MIT, working in

close collaboration with multiple departments at MIT. It is a service that has succeeded in bringing the best of MIT to alumni, business leaders and the general public.

African Virtual University

More than 190 students from eight sub-Saharan African countries (Ethiopia, Ghana, Kenya, Mozambique, Rwanda, Tanzania, Uganda, and Zimbabwe) participated in an MIT course without leaving their continent, through a partnership between CAES and the African Virtual University (AVU). Using asynchronous and synchronous methods, CAES offered a six-week curriculum loosely based on MIT's 1.00 Introduction to Computers and Engineering Problem Solving, which teaches the Java programming language. The resulting course, Java Revolution, was uniformly distributed regardless of equipment and bandwidth. Thirteen learning centers participated, and we expect to enroll more African students in MIT courses in the future. Java Revolution featured videotaped lectures via satellite, a web site for course materials, email moderated by teaching assistants, and two live videoconferences.

A two-day visit was organized for the CEO of AVU, Dr. Cheick Modibo Diarra, who attended MIT's Commencement as the guest of CAES when he met the senior administrators and faculty.

Two Interactive Web-Based Courses

CAES and the Harvard-MIT Division of Health Sciences and Technology, through a generous grant from Pfizer Inc., are creating a series of free, interactive web-based courses for healthcare professionals. Two are now completed; two more are in the beginning stages of development. The two completed sites include Good Practices in Clinical Research, a bilingual site in Spanish and English primarily for physicians in Latin America, and Fungal Infections: Virtual Grand Rounds, a complete teaching site in the diagnosis and treatment of fungal infections.

Fungal Infections: Virtual Grand Rounds (http://figrandrounds.org/) presents an overview of the most common types of fungal infections and provides the tools to diagnose and treat the disease. It offers lectures from world experts using the latest in streaming media technology, as well as a collection of interactive case studies that ask the physician to make critical decisions in each case. The site also offers an extensive searchable library of relevant journal articles and texts with abstracts provided by PubMed, a service of the National Library of Medicine. The site may be used as either a reference or a full course where users can identify different types of fungal infections and methods for diagnosis, select appropriate medications, and practice new skills to formulate a decision in case diagnosis and management.

The creation of this course is in response to the recent increase of patients with immunosuppressed diseases such as AIDS and also the increase in transplantation successes. Both groups are more susceptible to contracting a fungal infection. Another determining factor in creating this course is the increased availability of new antifungal drugs for treatment and the development of new diagnostic methods and strategies for controlling the disease.

With a full launch targeted for fall 2002, the goals of the Good Practices in Clinical Research site are to provide the tools needed by clinical investigators, create a network of investigators linked to each other and the pharmaceutical industry, and make a contribution to medical education. The course consists of approximately 20 lectures and two interactive exercises. In addition to the bilingual lectures, the site also includes a medical glossary and library of relevant reports and texts.

The library material not only includes current clinical research issues but gives a historical context—from the horrors of the Nazi experiments performed in the name of science to the Nuremberg Code, Declaration of Helsinki, Belmont Report, and recent international guidelines for global research development. Topics covered include a historical overview of clinical research, ethical considerations, pre and post trial considerations, conducting clinical trials, and the future of clinical research. The web site is also designed to address major obstacles in conducting clinical research in developing countries, such as the lack of well-trained clinical investigators and a defined regulatory framework. The site is completed and is now in the beta test phase with a small group of physicians prior to its fall 2002 launch.

The two new courses under development continue the series of training for global clinical investigators. They are Applied Statistics and Study Design. Both subjects are essential tools for the clinical investigator, whatever the discipline of the investigator. Both courses, currently taught each summer as part of a clinical investigators training program, are highly acclaimed by their students as being critical to their work as clinical investigators. Seeing the need to share this important curriculum beyond the fellows who participate in the program each year, we will convert these two live courses into interactive web courses that will reach a global community of individuals embarking on a clinical research initiative.

College Coach Virtual Learning Center

CAES provided project management for the development of this online, customized web site to guide families through the most important steps towards completing the college admissions process.

Academic Programs

NTUC/PBS the Business Technology Network

CAES continued the production and delivery of non-credit asynchronous professional development programs for PBS the Business Technology Network in 2001–2002. The single new program, Wireless Futures, was co-taught by Stuart Madnick, Richard Larson, Steven Lerman, and Jeffrey Schiller. A third and unprecedented fourth re-broadcast of Integrated Supply Chain Management, taught by Jeremy Shapiro, occurred during the 2001–2002 academic year. Certificates of completion for courses offered through NTUC/ PBS were issued to nearly 170 learners during this reporting period.

As in 2000, the relationship between CAES and NTUC/ PBS the Business and Technology Network experienced another transition this past year when the publicly held company Sylvan Ventures acquired National Technological University. Sylvan, with NTU as one of its divisions, is making strategic investments in online higher education and discussions with CAES regarding future distribution and delivery are ongoing.

Professional Institute

For the 36 programs advertised for the 2001 summer session, a total of 818 registrations were made. The average session had 22.7 registrations, compared to 24.1 in 2000 (41 programs) and 22.1 in 1999 (40 programs). Of the 818 registrants enrolled in the 2001 Summer Session, 80 percent were from industry, 11 percent from government, and nine percent from education.

Advanced Study Program

During fiscal year 2002 our objective was to expand the delivery of MIT-quality education to a broader market consisting of MIT alumni/ae worldwide. Due to the unfavorable economic environment in many countries, we expanded our distance-learning program to enable people in remote locations to access knowledge available at MIT without incurring travel expenses. ASP also introduced new distance learning courses in system dynamics and in web system architecture.

Our exploration of various marketing channels led us to professional societies and, by the close of the fiscal year, we concluded agreements with four of them. We expanded our advertising campaign to include a number of new media such as *Technology Review*, *Boston Metro*, *Mass High Tech*, and *The Educator*. In addition we listed our DL courses on a number of online listings and developed a marketing plan.

The successful Tokyo reception of 2000, held to promote the Advanced Study Program in Japan, was repeated in February 2002 with even more corporate participants attending.

We successfully negotiated agreements with the Institute of Electrical and Electronics Engineering, American Society for Mechanical Engineers, and American Society for Civil Engineering to promote our distance learning courses to their members. Negotiations are well along with the American Institute of Chemical Engineers as well. In cooperation with other CAES groups, we successfully concluded a trial arrangement with Sylvan Learning/NTU through which we will offer four of our distance learning courses to NTU students.

CAES strengthened its relationship with the System Design and Management Program (SDM) in two ways this year. The Advanced Study Program successfully offered a special online version of its "System Dynamics Foundations" course to SDM students as an elective during the 2001 summer term. Thus, SDM students were able to take advantage of a summer elective course without leaving their home/work sites. We have been asked to repeat this program again this summer. In addition, CAES's senior multimedia producer spent a portion of time working with SDM to improve the distance learning aspects of their program. CAES and SDM are looking at other ways to cooperate and collaborate in academics, as well as technology, support, and training issues.

We revised the system of accumulating costs of the distance learning courses to more accurately reflect the revenue/cost picture. Of particular note is an increase in revenues for this fiscal year of about 3 percent from the previous year in spite of adverse economic conditions worldwide with a particularly strong fall term enrollment. Recognizing the global financial crisis, we maintained tuitions at the previous levels.

Research Programs

Center for Educational Computing Initiatives

The Center for Educational Computing Initiatives (CECI) is a research division within CAES that focuses on emerging technologies for educational use and evaluates their effectiveness. CECI projects focus on collaborative learning and on enabling technologies for educational applications, including authoring systems and toolkits or libraries of computer code that make the creation of effective computer applications easier and less expensive. CECI also evaluates how computer technology affects education, particularly how computer applications improve the quality of education.

CECI served as the physical and intellectual home of OpenCourseWare during its startup, with Professor Steven Lerman, director of CECI also serving as chairman of the interim management team until May 2002. During that period he gave four major keynote addresses at conferences abroad and at several universities, including Lehigh and Duke. Fifteen pilot sites for OCW were created at CECI.

Professor Lerman was also appointed deputy co-director of the Singapore MIT Alliance and funds from SMA supported four doctoral students working on various research projects, including ideas for computer-supported learning.

CECI projects are as follows:

PIVoT, the Physics Interactive Video Tutor

Following several years of research and development, the Physics Interactive Video Tutor (PIVoT) has become a stable resource available both to the MIT community and to registered guest users worldwide. PIVoT is a web-based learning environment that supports the teaching of college undergraduates in core science courses—in this case, subject 8.01 Introductory Newtonian Mechanics. Its most substantial feature is 50+ hours' worth of streaming digital video, including 35 lectures and about 20 hours of tutorial help sessions. To provide ease of use, all of the video is presented in short, well-described segments with associated keywords and topics stored as metadata in the PIVoT database. Additional resources on the web site include a 600-page textbook, practice problems, java simulations, and answers to frequently asked questions. PIVoT also includes a customizable personal tutor feature that allows learners to select the type and level of tutorial support they are seeking. The PIVoT web site contains a complete set of study materials for any student taking first-semester physics at MIT or a similar course elsewhere. PIVoT attracts a steady, undiminished stream of guest users requests from around the globe, and while it is neither a commercially developed nor a commercially supported product, it is highly regarded, widely requested, and admired by users at MIT and abroad.

Two follow-on activities to the initial PIVoT research were completed in 2001–2002:

- A MIT-educated physicist conducted an exhaustive review of the PIVoT site and made detailed recommendations to improve the video segment descriptions and the organization of the content. This resulted in a much-improved site, providing users with more targeted, accurate, and useful search results.
- Funding was obtained for the videotaping of second-semester physics lectures on Electricity and Magnetism, in anticipation of building a future "PIVoT 2" web site for this subject matter. Live lectures were videotaped during fall 2001, digitized, and posted to the course web site throughout the semester. Final edited lecture videos will be completed by the end of summer 2002. The completion of a PIVoT 2 site will be contingent upon additional funding. Members of the MIT community are welcome to register for a PIVoT account, available at http://curricula2.mit.edu/pivot/.

Access to PIVoT Project

Since December 1999, the National Center for Accessible Media (NCAM) at the WGBH Education Foundation in Boston has worked in collaboration with the CAES PIVoT team to research techniques and best practices for making web sites with complex scientific content accessible to users with hearing and vision disabilities. The team has focused on several aspects of this work, including:

- Creation of text captions for about 40 hours of Professor Walter Lewin's Newtonian physics lectures and tutorial help session videos, to be used by hearing-impaired users and other types of learners
- Audio descriptions for a small sample of the video segments, which provide visually impaired users with more complete information about the video
- Creation of alternate text tags for all graphical elements, as well as other features that support efficient access by visually impaired users via screen reader technology
- Improved web site layout for easy navigation by visually impaired users
- Audio descriptions of textbook graphics, again for visually impaired users

It is worthy of note that students created much of the work needed to implement these accessibility features. While the results met with varying degrees of success, it is important to acknowledge that a number of MIT undergraduates made substantial, thoughtful, and well-executed contributions to the project and to the research.

As we approach completion of the three-year project, co-funded by the National Science Foundation and the Mitsubishi Electric American Foundation, NCAM is working on a set of guidelines and recommendations that will be published in print and electronically by the end of 2002. More information about the research can be found at the WGBH web site: http://ncam.wgbh.org/webaccess/pivot/.

Other continuing projects include:

TEAL

During the fall term of 2001, the Technology Enabled Active Learning (TEAL) project implemented an entirely new version of 8.02 Electricity and Magnetism using the TEAL classroom. This "active learning" approach is a highly collaborative, hands-on environment with extensive use of desktop experiments and educational technology. The results of this new teaching method have been evaluated and results will be incorporated in next year's teaching when all 8.02 students will be taught 8.02 in the TEAL studio.

Studio 1.00

CECI is pioneering an active learning approach involving studio-style teaching in MIT subject 1.00 Introduction to Computers and Engineering Problem Solving—fundamental software development and computational methods for engineering and scientific applications. This past year every third class was held in a lab setting, with students in pairs with a laptop. Next year, we will expand active learning sessions so that by the spring, all classes will be delivered using this active learning method.

Jewish Women's Archive

This web site, devised to uncover, chronicle, and transmit the historical record of Jewish women's lives, continues with the database now converted to Oracle to reduce the search base and the development of a new administrative interface. Future funding has been sought for Weaving Women's Words—an oral history project.

Hewlett-Packard–MIT Partnership

This partnership funded research on collaborative learning tools for use in software development projects. A group at CECI is developing an experiment in which teams of students are assigned a software design and implementation problem. Each team is provided with different software tools to enable some degree of collaboration at a distance. The goal is to assess the potential usefulness of collaborative tools by determining the effectiveness of the team in reaching established goals.

Masters' Voices

This year saw completion of the Masters' Voices™ Web project, conceived of as a means to preserve and communicate a unique and valuable body of knowledge accrued by Ford engineers through many years of experience. The purpose of the project was to research how streaming video and other web-based multimedia technologies could be used to capture the expertise and wisdom of veteran engineers, and to readily and meaningfully transmit this knowledge to rising young Ford engineers. The project has the potential to significantly benefit Ford by guiding less experienced engineers to avoid design and engineering errors that can cause repeated, costly recall campaigns

Visitors and External Relations

In 2001, CAES hosted 50 group and individual meetings during the year, giving presentations on distance learning and technology-enabled education at MIT. These included visitors from the UK, Hong Kong, Japan, Malaysia, France, Korea, Netherlands, Singapore, Algeria, China, and Germany. Two major delegations came to us via MISTI Germany (under secretary for education and six colleagues) and MISTI China (25 educators), in addition to corporate leaders from the ILP.

Published articles about CAES and its projects appeared in *IS Newsletter*, *Research Digest*, *IT Report*, *Educational Pathways*, *Technology Review*, *Boston Business Journal*, and *Elearn Magazine*.

Finances and Funding

With funding provided by the Office of the Provost, CAES was able to hire a project manager for MIT World to build and market the site and provide streaming video of 75 public events at MIT and measure its effectiveness. MIT World has secured funding for its second year of operations from the Alumni Association, the Industrial Liaison Program, and the Lord Foundation of Massachusetts. This funding will allow MIT World to more than double the number of videos available to 150, and make some significant changes to the organizational aspects of the web site. These changes include making the site a database-driven, searchable site with features that enable easier updating as well.

With financial support from Pfizer, CAES and the Harvard-MIT Division of Health Sciences and Technology created the first two in a series of free, interactive web-based courses for healthcare professionals: Good Practices in Clinical Research and Fungal Infections: Virtual Grand Rounds (see section on accomplishments above).

The Lord Foundation supported the videotaping of second-semester physics lectures on electricity and magnetism, in anticipation of building a future PIVoT 2 web site. The PIVoT team continues to collaborate with WGBH's National Center for Accessible Media (NCAM) to research web accessibility for deaf and blind users, and funds from the National Science Foundation and the Mitsubishi Electric American Foundation enhanced accessibility to the PIVoT web site (see section on accomplishments above).

The Lounsberry Foundation awarded a grant of $50,000 towards a conference and the planning of a new initiative, the Learning International Networks Consortium planned for fiscal year 2003.

Future Plans

CAES continues to reorganize, and next year the Professional Institute and Advanced Study Program will become part of the School of Engineering. The focus of CAES in the future will be outreach beyond the MIT campus with an emphasis on research and development in technology-enabled education. CAES will continue to work with AMPS to develop asynchronous teaching and learning with current projects such as MIT World and future planned interactive web sites. We plan to expand video tutors to new subjects reaching audiences in Asia; and to develop projects to empower educators in developing countries to create tertiary education programs and projects using technology-enabled distance learning through a new initiative entitled the Learning International Network Consortium (LINC).

We will build on relationships initiated this fiscal year with external partners such as the African Virtual University and National Technological University; and we will work closely with internal MIT projects and departments such as OpenCourseWare and the Council on Educational Technology. We plan three new interactive web sites for the medical community.

Personnel

The following staff changes occurred during fiscal year 2002: Laura Koller won the Infinite Mile Award; Pam Homsy was promoted to administrative officer of CECI effective May 2002; Sen-Ben Liao joined CECI as a visiting scientist in August 2001; Michael Danziger joined CECI as a technical assistant on a 12-month temporary appointment; and Norman Derby returned to Bennington College in June 2002, after spending one year with CECI as a visiting scholar.

Publications

The following papers, articles and books were published or are in process this year:

- Maureen Devlin, Richard C. Larson and Joel W. Meyerson (eds.), *The Internet and the University 2000 Forum*
- Richard C. Larson and Joel W. Meyerson, "We've Got the Steam Locomotive—Now Let's Design the Railroad Cars!" Preface in *The Internet and the University 2000 Forum.*
- R.C. Larson, "Public Sector Operations Research: A Personal Perspective," in *Operations Research*
- Richard C. Larson, "The Future of Global Learning Networks," in *Education India – 2002.*
- Y.J. Dori and M. Barak, "Virtual and Physical Molecular Modeling: Fostering Model Perception and Spatial Understanding," in *Educational Technology & Society* (http:///ifets.ieee.org/periodical/vol_1_2001/dori.pdf)
- U. Zoller, Y.J. Dori and A. Lubezky, "Algorithmic and LOCS vs. HOCS Chemistry Exam Questions: Performance and Attitudes of College Students," in the *International Journal of Science Education*
- Y.J. Dori and M. Hameiri, "Multidimensional Analysis System for Quantitative Chemistry Problems Symbol, Macro, Micro and Process Aspects," in the *Journal of Research in Science Teaching*
- Y.J. Dori, "From Nationwide Standardized Testing to School-based Alternative Embedded Assessment in Israel: Students' Performance in the 'Matriculation 2000' Project," in the *Journal of Research in Science Teaching*. In press.
- Y.J. Dori, "A Framework for Project-Based Assessment in Science Education," chapter in a book series, In *Optimizing New Modes of Assessment*

Conferences and Panels

Professor Richard C. Larson gave the following service to the profession:

- National Science Foundation: invited speaker and group leader, workshop on "Responding to the Unexpected," a focus on homeland security, 2001
- National Academy of Engineering, peer review committee member
- Section 8: Industrial, Manufacturing and Operational Systems Engineering (2001—vice chair and chair, Sec. 8 Search Committee, 2002-2003, chair), 2000-2002
- National Academy of Engineering, member, Draper Prize Selection Committee, 2002-2003

Professor Richard C. Larson gave the following presentations and foreign lectures:

- Algiers, Algeria. Invited plenary speaker at the Second International Conference on the Virtual University, on the theme "Internet: A Pedagogical Tool for Distance Learning." Ministry of Higher Education and Scientific Research, The "Université de la Formation Continue.", 2001.
- Hong Kong. As Sir Edward Youde Memorial Fund Visiting Professor, a series of six invited lectures at the University of Hong Kong, Chinese University of Hong Kong, and the Hong Kong University of Science and Technology, 2002.
- Presentation on PIVoT at Sloan Foundation, ALN conference, Orlando, on Asynchronous Online Tutoring: Using Multimedia to Teach Difficult Concepts (with Laura Koller), 2001.

Dr. Judy Dori gave the following presentations:

- Invited talk: Y.J. Dori, "Assessing the Effect of Visualization on Students' Understanding of Scientific Concepts," Science Education and Visualization - Gordon Research Conference, Mount Holyoke College, South Hadley, MA, http://www.grc.uri.edu/programs/2001/sciedu.htm.
- Y.J. Dori and J. Belcher, "Assessing Students' Conceptual Understanding in the Technology-Enabled Active Learning (TEAL) Project." Paper presented at the 9th European Conference for Research on Learning and Instruction, Freiburg, Switzerland, 2001.

Richard C. Larson
Director
Professor of Electrical Engineering

More information about the Center for Advanced Educational Services can be found on the web at http://caes.mit.edu/.

Center for Archaeological Materials/ Center for Materials Research in Archaeology and Ethnology

The mission of the Center for Materials Research in Archaeology and Ethnology (CMRAE), a consortium of eight Boston-area educational and cultural institutions, is to advance our understanding of prehistoric and non-industrial societies through analysis of the structure and properties of materials associated with human activity. Plant and animal food remains, human skeletal material, as well as metal, ceramic, stone, bone, and fiber artifacts, are the objects of study, along with the environments within which these materials were produced and used. At the Center for Archaeological Materials (CAM) at MIT, investigators concentrate on the materials processing technologies that transform natural materials into cultural objects.

At MIT, CAM is administered by the Department of Materials Science and Engineering (DMSE). In 1998–1999 DMSE established a new, undergraduate major in archaeology and materials, Course III-C, as well as an interdisciplinary doctoral degree program in archaeological materials. These are the only academic degree programs of their kind in the United States. During AY2002 two graduate students were enrolled in the PhD program and two majored in Course III-C.

Archaeological Science, the CMRAE/CAM undergraduate subject introduced during the 1995–1996 academic year, and offered jointly by DMSE and the Chemistry Department, continues to enjoy high popularity among students from CMRAE institutions. Fifty-four students enrolled: 35 from MIT, four from Boston University, nine from Harvard University, three from the University of Massachusetts, and three from Wellesley College; twelve faculty members from five CMRAE institutions lectured in the subject.

CMRAE and DMSE jointly received a grant in May 2001 from the Division of Materials Research at NSF. The $750,000 award will support an MIT Summer Institute in the Materials Science of Material Culture over the course of three years. Professor Heather Lechtman is principal investigator for the project: Professors Dorothy Hosler, Linn Hobbs, and Samuel Allen are co-PIs. The purpose of the Summer Institute (SI) is to assist professors at liberal arts colleges in introducing materials science and engineering to their undergraduate curricula. At each two-week SI session, MIT faculty, faculty from undergraduate liberal arts institutions, and DMSE archaeological materials graduate students supported by the grant will consider case studies that combine materials science and engineering with social science and humanities fields. The case study modules will include intensive laboratory exposure to the processing and testing of materials. The pedagogic aims of the modules are to put people at the center of the materials polyhedron described by structure/properties/processing/ and product, and to provide case studies exemplifying these relationships that college professors can use to present engineering science and human sciences to their students.

The first two-week Summer Institute convened in June 2002. Twelve faculty members from 12 liberal arts colleges represented the fields of archaeology, chemistry, civil engineering, materials engineering, mechanical engineering, and science, technology and society (STS). Professor Hobbs taught the first one-week module: Monumental Glue; Professor Lechtman taught the second one-week module: The Power of Metal in the Andean World. Both modules incorporated intensive, hands-on laboratory sessions providing the SI participants with a range of practical experience in the processing of mortars, metals, and alloys that they can call upon for use with their students. The two-week schedule included an evening lecture by Professor Hosler on Mesoamerican Metallurgy and another by Professor Allen on Japanese and Damascus Swords. SI participants were highly committed, enthusiastic, and used their time together at MIT to discuss plans for incorporating the SI module material into their own curricula.

The SI philosophy is based on principles the PIs consider fundamental to the design of higher education in the 21st century: (1) that science and engineering have their origins in multiple cultural traditions which account for their richness and permanence in human endeavors; and (2) that access to the social wealth of society lies in education that allows people to generate and interpret a wide range of data from a broad methodological base.

Heather Lechtman
Director
Professor of Archeology and Ancient Technology

More information about the Center for Archaeological Materials/ Center for Materials Research in Archaeology and Ethnology can be found on the web at http://web.mit.edu/cmrae/cmrae_home.htm.

Office of Educational Opportunity Programs

The Office of Educational Opportunity Programs was created in January of 1992 to organizationally locate the MIT/Wellesley Upward Bound Program, the MIT Educational Talent Search Program (ceased operation in FY1998), and all future programming serving low-income community youth. MIT has operated the Upward Bound Program since 1966 and began operation of the Educational Talent Search Program in September of 1991.

Upward Bound and Educational Talent Search are two of six US Department of Education: Special Programs for Students from Disadvantaged Backgrounds (TRIO programs) created under the Higher Education Act of 1965.

The goal of these programs is to provide college admission and preparatory information, academic support, advising, career information, and college and career exploration opportunities to the economically and/or educationally disadvantaged youth of Cambridge and formerly Somerville.

To a large extent, the development of both programs was influenced by the research done by psychologist Kurt Lewin and his associates. Lewin's hypothesis was that ego growth and academic performance were closely related. Moreover, he concluded that a developing ego needs to experience success in a warm and personal, structured environment for greatest development, in both a personal and social sense. Lastly, it was determined that this personal and social growth could be achieved through intervention outside the institutions of family and school. Educational Talent Search and Upward Bound, through their year-round academic support and advising, and cultural experiences represent just such interventions.

MIT/Wellesley Upward Bound

The MIT/Wellesley Upward Bound Program is a year-round, coeducational, multi-cultural, college preparatory program for high school youth who reside or attend school in Cambridge. Currently in its 35th year, the program serves 70 academically promising young men and women from disadvantaged backgrounds. The goal of Upward Bound is twofold: to motivate client high school youth such that they persist on to post-secondary education; and, at the same time, to provide them with the fundamental skills necessary for success at the collegiate level.

The following is an overview of the program's operational phases.

The six-week summer program, conducted in residence at Wellesley College, is designed to provide the participants with a rigorous academic experience. Classes are taught by experienced high school teachers, and graduate and undergraduate students from MIT, Wellesley College, and other local colleges and universities. Each participant is required to enroll in a mathematics course, an English course, and an elective course: social studies, science, or world languages. (Additionally, due to an agreement with the Cambridge Public Schools, students may receive summer school credit for up to two failed major courses taken during the preceding school year.)

The academic-year program, located at MIT, plays an equally important role in the educational development of participants. Building upon the motivation and enthusiasm developed during the summer, the academic-year program is designed to assist and support the participant while in school. To accomplish this task, programs staffed primarily by MIT and Wellesley College students, when appropriate, have been developed. (We continually strive to maintain MIT and Wellesley College students' participation through our continued involvement as a pre-practicum site for the Wellesley College Teacher Certification Program and through various outreach efforts.)

The Upward Bound office is open for study, on a drop-in basis, four days a week. Tutors are available to assist participants with homework problems in addition to meeting individuals and/or small groups for specific content-area tutorials.

The program offers workshops monthly to address more specialized participant needs (e.g., SAT preparation, computers, study skills development, time management, job readiness skills, etc.).

Also, in an effort to help participants cope with a myriad of problems—academic, social, family, etc.—the program offers support in the areas of guidance, college, career, and personal adjustment. The college advising component includes campus visits to many local colleges and universities, as well as to historically black institutions, and participation in at least two local college fairs. The program hosted its Annual College Day Program in July during the summer session at Wellesley College. There were approximately 70 colleges and universities represented, as well as five visiting Upward Bound Programs from the greater Boston area. The career-advising component offers exposure to career options through our Speaker Series Program, as well as through research on the internet.

Lastly, the program provides numerous field trips that have as their purpose the intellectual, social, and cultural development of the participants. Such trips included the Museum of Science, the Omni Theater, dramatic productions, Museum of Fine Arts, skiing, bowling, and roller-skating.

Seventy-seven percent of the program's graduating seniors have been accepted into post-secondary educational institutions. The program's Class of 2002 has enrolled in the following colleges and universities: Alabama State

College, Bridgewater State College, Florida Agricultural and Mechanical University, Massachusetts Bay Community College, Massachusetts College of Liberal Arts, University of Massachusetts at Amherst, University of Massachusetts at Boston, University of New Hampshire, and University of New Haven.

Ronald S. Crichlow, Director of Educational Opportunity Programs
Evette M. Layne, Director, MIT-Wellesley Upward Bound Program

McGovern Institute for Brain Research

The McGovern Institute for Brain Research at MIT is a research and teaching institute committed to advancing human understanding and communications. The goal of the McGovern Institute is to investigate and ultimately understand the biological basis of all higher brain function in humans. The Institute is conducting interdisciplinary research that combines and extends the results of recent breakthroughs in three major, interrelated areas: systems and computational neuroscience, imaging and cognitive neuroscience, and genetic and cellular neuroscience.

Personnel

James DiCarlo, a McGovern investigator and assistant professor in the Department of Brain and Cognitive Sciences, arrived this past year and set up his laboratory. Professor DiCarlo examines object recognition by the inferotemporal (IT) cortex, which is thought to be critical for visual recognition. He researches how the brain extracts object identity regardless of object position, size, view, illumination, and the presence of distractions. He is particularly interested in how a single object presented at different distances and from different perspectives stimulates the IT region.

Activities

The McGovern Institute held its inaugural symposium, New Approaches in Neuroscience, in May 2002. The key sessions were Novel Avenues for Electrophysiology, Genes in Neuroscience, Imaging the Brain, and Neural Stem Cells and Repair. Major sponsorship of the symposium was provided by Merck Research Laboratories, with additional sponsorships by Schering-Plough Research Institute, Amgen, Pfizer, Genzyme, and Transkaryotic Therapies.

The McGovern board of directors held its first meeting on October 29, 2001. Members of the board are Patrick McGovern, Lore McGovern, Elizabeth McGovern, Gerald Fischbach of Columbia University, Robert Langer from MIT, Edward Scolnick from Merck and Company Inc, Robert Silbey from MIT, Sheila Widnall from MIT, and Torsten Wiesel of Rockefeller University

The institute is also guided by a distinguished scientific advisory board composed of some of the world's most prominent neurobiologists. It held its first meeting on March 19, 2002, and spent the day meeting with the McGovern investigators. At the end of the day they gave a report to Patrick and Lore McGovern, Robert Brown, and Robert Silbey. Members of the board are John Duncan, Medical Research Council, England; Eric Kandel, Columbia University; Nikos Logothetis, Max-Planck Institute for Biological Cybernetics; William Newsome, Stanford University Medical School; Carla Schatz, Harvard Medical School; Charles Stevens, Salk Institute; and Robert Wurtz, National Eye Institute.

Awards and Honors

Emilio Bizzi was named Institute Professor, the highest honor awarded by the MIT faculty and administration. He was cited for his work in the field of motor control, an area of neuroscience that deals with the generation and control of movement by the brain, and for his discoveries about the way the nervous system creates and coordinates complex movements."

James DiCarlo was named a 2002 Pew Scholar in the biomedical sciences by the Pew Charitable Trusts. These awards are granted to young investigators who show outstanding promise in the basic and clinical sciences and are intended to encourage scholarly innovation in their research and to help them advance the state of knowledge in the biomedical sciences. DiCarlo is also the recipient of an Alfred Sloan Research Fellowship.

Ann M. Graybiel was named a recipient of the 2001 National Medal of Science. The National Medal of Science is the nation's highest science and technology honor and recognizes individuals in a variety of fields for pioneering scientific research and for their lifetime achievements. In addition, Graybiel was named the 2002 recipient of the James R. Killian Faculty Achievement Award, which recognizes extraordinary professional accomplishment by full-time members of the MIT faculty. Graybiel's research focuses on the neurophysiology of the basal ganglia, brain regions implicated in the control of movement and cognition, as well as our ability to acquire habit.

In the fall of 2001, H. Robert Horvitz received the 14th Annual Bristol-Myers Squibb Award for Distinguished Achievement in Neuroscience Research for his landmark discovery that specific genes control programmed cell death, or apoptosis.

Research Accomplishments

During the past year the Kanwisher lab and collaborators reported that they identified a part of the brain that responds primarily to images of the human body or parts of the body. With the help of state-of-the-art brain imaging, Kanwisher and colleagues had previously uncovered the parahippocampal place area, which responds to photographs of indoor and outdoor scenes, and the fusiform face area, which responds exclusively to faces. The newest region is on the lateral surface of the brain, just inside the skull from a point behind the ears.

Tomaso Poggio and Tony Ezzat, an MIT graduate student in electrical engineering and computer science, have simulated mouth movements that look so real, most viewers can't tell that Mary 101 isn't an ordinary videotape of a person speaking. Given a few minutes of footage of any individual, the researchers can pair virtually any audio to any videotaped face, matching mouth movements to the words.

The Sharp lab and collaborators reported on a form of RNA developed at MIT which has inhibited replication of HIV-1 virus in human-derived cell lines, potentially showing a new way to combat AIDS. The in vitro work uses RNA interference (RNAi), a naturally occurring technology used by a variety of organisms to silence genes.

Phillip A. Sharp
Director
Institute Professor

More information about the McGovern Institute for Brain Research can be found online at http://web.mit.edu/mcgovern/.

Council on Primary and Secondary Education

The Council on Primary and Secondary Education (CPSE) develops programs that bring the strengths of MIT to bear on the American K–12 educational system. The projects sponsored by the council include the MIT/Wellesley Teacher Education Program, Teacher Sabbaticals, and Educational Outreach Programs. The council's chairman is also involved in a number of K–12 educational efforts, including the *Science and Engineering Program for Teachers* and its product, the *Network of Educators in Science and Technology*, as well as a collaboration with the Association of American Universities (AAU).

MIT/Wellesley Teacher Education Program

To foster the growth of a cadre of new teachers who meet MIT's standards of excellence in science and mathematics, yet appreciate the value of different ways of approaching and understanding a problem, MIT has created a joint program with Wellesley College, the Teacher Education Program (TEP). It prepares undergraduates for Massachusetts State Certification in mathematics and science at the middle and high school levels. This program, started in the fall of 1993, has its administrative home in MIT's Department of Urban Studies and Planning. Undergraduates in the program must complete a major in the subject area in which they wish to teach. In addition, they must complete three courses at MIT and two at Wellesley; one of the latter is a seminar taken in conjunction with the required 150 hours of supervised practice teaching. Students must also complete 75 hours of supervised classroom observations.

TEP is led by Dr. Eric Klopfer, the Joseph B. ('54MG) and Rita P. Scheller professor of teacher education. TEP enrollment in the AY2001 reached 35 students from 16 departments, and is the largest in the history of this program. Although the administrative home for TEP is in the Department of Urban Studies and Planning, students come to the program from a multiplicity of disciplines. During the past year Professor Klopfer has moved into a newly renovated office and laboratory. The latter is an electronic classroom dedicated to the use of educational technology in science education. Eric's emphasis on simulation and modeling of chemical, physical and biological phenomena as a tool in science education is drawing considerable attention as is his newly published book "Adventures in Modeling: Exploring Complex, Dynamic Systems with Star Logo" with co-authors Venessa Colella and Professor Mitchell Resnick from MIT's Media lab.

Teacher Sabbaticals

The Class of 1952 Educational Initiatives Fund launched the MIT Teacher Fellows Program, which brings middle and high school teachers together with MIT faculty. Not only is this program effective in helping teachers develop new and creative ways to teach math and science, it allows MIT faculty to share their expertise in the development of K–12 math and science curricula.

Ken Brody, retired from Boston Technical High School, will return to MIT in AY2003. Mr. Brody continues to serve as the Secretary of the Network of Educators in Science and Technology (NEST). Additionally, he arranges tours of MIT by NEST teachers and students. We are pleased to have precollege educators with us. Their understanding of the needs of classroom teachers is essential to the development of MIT's agenda in K–12 education.

Educational Outreach Directory

The council's booklet MIT's *Educational Outreach Programs* continues to be widely circulated. Approximately 65 programs are listed; programs are either conducted on MIT's campus or have the involvement of people from MIT's faculty, staff, or student body. The directory is now also available through the council's home page on the web. Activities range from the *Chemistry Magic Show*, a 45-minute-long road show of attention-getting chemistry experiments along with a running commentary, to the *Voyage of the MIMI*, an interdisciplinary, multimedia math and science presentation geared toward 4th–8th graders using connected educational television, software, and other instruction materials.

Programs by the CPSE Chairman

Association of American Universities

The Association of American Universities (AAU) Task Force on K–16 Education, which I chair, continued its work during the past year. The task force hosted a Forum on Best Practices in Teacher Education at the House of the American Academy of Arts and Sciences in Cambridge on 30 September–2 October. The goal of this forum was to provide all the AAU member institutions with the intellectual and programmatic means to establish programs on their campuses that will certify disciplinary majors to teach at the precollege level. This is in response to the adoption by the presidents and chancellors of the AAU institutions of the task force's resolution on teachers education, which encouraged the establishment of such programs on the AAU campuses. More than 120 people representing AAU member institutions attended this forum, which was web cast.

The AAU initiative Standards for Success (S4S) moved into its third year of work. With $2.4 million of support, largely from The Pew Charitable Trusts, this program will provide admissions officers with the tools to compare

the qualifications and skills of students from states with different proficiency standards. Tools developed by S4S will enable AAU universities, and others as well, to make better informed admissions and placement decisions about incoming students.

In addition, with encouragement from the National Science Foundation and MIT's Center for Materials Science and Engineering as a model, the task force is working to make research experience available to in-service teachers on the campuses of all 63 member institutions. During the summer of 2002 we will have 12 such teachers at MIT in a variety of center and laboratory settings: the Center for Materials Science and Engineering, the Biotechnology Process Engineering Center, and the Center for Environmentally Benign Semiconductor Manufacturing. My goal is to accommodate 50 people each summer. If all AAU member institutions were to develop similar initiatives, we would collectively reach thousands of in-service teachers each year with such experience.

Science and Engineering Program for Teachers

Professor Latanision directs the Science and Engineering Program for Teachers, which shares the council's goal of science literacy for all students. Key to a good education is an enthusiastic, knowledgeable teacher. Since 1989, this program has endeavored to give educators a unique perspective of how the basic sciences, mathematics and engineering are integrated to meet the technological challenges and needs of commerce and society. Our Science and Engineering Program for Teachers continues each summer with sustaining support from MIT alum H. Johan von der Goltz ('60MG), founder and general partner of Boston Capital Ventures. During summer 2001, of the 74 participants who attended, 22 were from countries other than the US—Argentina, Hong Kong, Norway, Lebanon, and Saudi Arabia. We had a waiting list of over 50 people that we would like to have had at MIT. The alumni of this program, The Network of Educators in Science and Technology (NEST), are truly outstanding teachers. During the past summer we set a record for alumni involvement in this program as 14 MIT alumni clubs around the world sponsored 43 teachers who participated in the program. After our Friday evening banquet, Johan made bilingual remarks for the benefit of our guests from abroad. Johan preceded Radio Hall of Famer Fred Foy, our dinner speaker. Fred was the announcer for *The Lone Ranger* show on radio and television and later for the *Dick Cavett Show* on television.

The alumni of this program, now totaling approximately 900 people, become members of the Network of Educators in Science and Technology (NEST). This year, NEST members came to MIT's campus on June 28 for a two-day meeting to assess the program and determine future directions for the organization. The year 2002 agenda for returning NEST alums represents a continuing alliance between NEST and MIT's Center for Materials Science and Engineering. CMSE director Michael Rubner arranged a full-day program for NEST on 28 June. NEST teachers also participated in the Star Logo Community of Learners Workshop aimed at developing useful, curriculum supporting modeling tools. The workshop, 24 June–3 July, was led by Professor Klopfer and supported by the Siemens Foundation. The annual fall retreat of NEST was held in Milford, MA, on 9–10 November 2001.

Once again eight Siemens Scholars were identified from among the participants in the Science and Engineering Program for Teachers. These teachers were supported during their visit to MIT by the Siemens Foundation. In addition, the foundation provided the resources for MIT's first Siemens Teacher Fellow: a teacher, Rebekah Ravgiala, was in residence at MIT during the summer of 2001 as a member of the research team of Professor Michael Rubner, director of the Center for Materials Science and Engineering. The object of this effort is to make research experiences available to in-service teachers. It is my goal to have 40–50 such teachers on campus during the summer in a few years.

R. M. Latanision
Chairman
Director, H H Uhlig Corrosion Lab

More information about NEST and the Council on Primary and Secondary Education can be found on the web at http://web.mit.edu/cpse/.

OpenCourseWare

Academic year 2002 was the inaugural year for MIT OpenCourseWare, a large-scale, web-based electronic publishing initiative funded jointly by the William and Flora Hewlett Foundation and the Andrew W. Mellon Foundation, and MIT. OCW's overarching goals are to:

- Provide free, searchable, coherent access to virtually all MIT course materials for educators, students, and individual learners around the world
- Create an efficient, standards-based model that other universities may emulate to publish their own course materials

Current Goals, Objectives, Priorities

This first year was a period of ramp-up and pilot development. Key goals we pursued during this time include:

—Launch public pilot this fall. Having experimented with different designs and different modes of working with MIT faculty during the course of the initial year, we will be opening a pilot version of OCW in fall 2002. The pilot version will consist of two separate sites, one for internal MIT use, the other for external access. The internal pilot will carry approximately 50 MIT courses, the external 30.

—Ramp up OCW organization. At June 30, OCW staff include the executive director, two faculty liaisons, an administrative officer and an administrative assistant. Recruitment is actively underway for the publications production director, technology director, evaluation specialist, and communications manager.

OCW has been guided by an Interim Management Board consisting of five members of the MIT faculty and senior academic staff: Vijay Kumar, Ann Wolpert, Dick Yue, Marc Kastner, and Steven Lerman. The provost will be appointing a permanent faculty advisory committee to succeed the IMB.

—Establish interim IP/copyright guidelines and clearance process. In order to publish and distribute MIT courseware, we must clear (obtain permission for) "third party materials" with copyright owners. "Third party materials" are objects such as photos, graphs, and readings created by others that faculty have incorporated into their course materials. We will institute a process for identifying and then either clearing or replacing such objects.

—Establish initial technology platform. The "platform" consists of servers and network distribution services. We have been reviewing services within and outside MIT to find the appropriate technologies and service providers.

—Develop plan for 2003. Even as work proceeds for the fall 2002 delivery of the initial OCW public pilot, we are planning for future editions of OCW and for the systems and infrastructure to support this. Planning tracks include determining the next wave of courses to be published, designing a more efficient content collection and publication process, developing requirements for a content management system, and establishing an evaluation and reporting process.

Accomplishments

During AY2002, the following key milestones were reached:

—Completed internal pilot (20 courses) to experiment with design options and establish methods of interaction with faculty. This pilot was used to demonstrate to faculty and to the OCW sponsors the concept and future promise of OCW.

—Hired executive director. After an extensive recruitment effort, Anne Margulies was hired to fill this position. Her appointment in May 2002 brings more focused planning and direction to OCW and opens the door for following through with the OCW organizational development process.

—Developed plan for 2002 pilot launch. Included selection of initial courses to be piloted based on criteria that assure reasonable depth and breadth in the initial OCW publication.

—Designed OCW organization. OCW is a unit within the Office of the Provost. The organization comprises four main components: publications production (faculty liaisons, designers, web site builders, copyright clearance specialist); technology (systems administration, helpdesk/support, operations liaison); evaluation; and communications.

Finances and Funding

The pilot phase of OCW, which began July 1, 2001, runs through September 30, 2002. Funding for this pilot phase comes from the William and Flora Hewlett Foundation ($5.5 million), the Andrew W. Mellon Foundation ($5.5 million), and MIT.

Future Plans

For the coming year, OCW's plans include:

—Complete pilot phase of OCW. This will involve publishing hundreds more courses. We also will design and implement a more efficient course publishing process and migrate from the mostly manual process we have in place today. As the initial pilot rolls out to the public, we will begin to measure and evaluate OCW usage.

—Build long-term technology infrastructure. Our goal is to implement a content management system that is scalable, reliable, cost-effective, and user-friendly. We are also committed to a system that, over time, will be

fully OKI compliant (OKI—Open Knowledge Initiative: The evolving OKI standard is a specification for the structure, format, metadata, and other attributes of course information. Such standards will facilitate exchange of course materials among institutions and among learning management and course management systems that follow them.) We expect that part of this system will include appropriate authoring tools that will allow MIT faculty and their assistants to develop and maintain their course materials for OCW publication.

—Share findings with other colleges and universities. One of the goals of OCW is to encourage others to emulate the OCW model so that, over time, a rich body of course materials will be available and sharable among institutions around the world.

Personnel Information

Appointments as of June 30, 2002 are Anne Margulies, executive director; Pamela Homsy, administrative officer; Tamara Cupples, faculty liaison; John Dennett, faculty liaison; and Stephen Downey, administrative assistant.

Anne Margulies
Executive Director

More information about MIT OpenCourseWare can be found on the web at http://ocw.mit.edu/.

Center for Environmental Health Sciences

The Center for Environmental Health Sciences (CEHS) pulls together the cross-disciplinary research and education efforts of some 27 members of the MIT faculty, plus five research staff scientists. In the past year, the center has undergone a change in leadership and research emphasis, with a program that applies a broad range of cutting edge technologies to the common goals of defining the impact of environmental agents on biological systems and identifying environmental causes of human disease. The center is funded by NIEHS and its associated research programs are funded through a variety of sources including NIGMS, NCI, DOE, NSF, ACS and DARPA. The many and varied research programs provide challenging interdisciplinary problems for postdocs, graduate and undergraduate students.

Simply stated, the mission of CEHS is to explore the biological effects of exposure to environmental agents, in order to understand and predict how such exposures affect human health.

The research activities in the center have been organized into six research cores, namely: signal transduction, mutation and cancer, free radical chemistry and biology, molecular, cell and tissue engineering for toxicology, environmental systems and health, computation and structure. A brief description of the goals of each research core are presented below.

The CEHS research activities are supported by four facilities cores that provide state of the art technologies for solving environmental health problems. The bioanalytical core facility and the accelerator mass spectrometry core provide central resources that provide expertise, training, and access to a wide variety of instrumentation, including (accelerator) mass spectrometry, liquid chromatography, and fluorescence spectroscopy. The Genomics, Proteomics and Bioinformatics Core Facility offers sophisticated DNA microarray analysis for transcriptional profiling as well as bioinformatics tools for the analysis of the full spectrum of cellular responses to environmental agents. Finally, the Molecular and Cellular Imaging Core provides state of the art cell and molecular imaging instrumentation, including 2-photon spectroscopy and laser scanning microscopy. Brief descriptions of each core facility are presented below.

The academic Biological Engineering Division allied with the Center for Environmental Health Sciences offers graduate education in molecular and systems toxicology and cross-disciplinary graduate opportunities in environmental health science and engineering with many departments in the Schools of Science and Engineering. Central to this educational effort, is an NIEHS-funded training grant.

The molecular and systems toxicology core curriculum emphasizes integration of chemistry, molecular biology, and genetics with bioengineering approaches to understanding how organisms respond to environmental agents.

Research Cores

Mutation and Cancer Research Core

Directed by Professor John Essigmann, the objective of this research core is to use chemical, biochemical, genetic and whole animal approaches to understand the underlying mechanisms by which genetic change is induced following environmental insults. The expertise base of the core participants is very broad, including synthetic and analytical chemistry; mammalian, yeast and bacterial genetics; construction of transgenic animals; and expression array studies of mammalian and bacterial proteins and mRNAs induced following exposure to DNA damaging agents. Some probe the details of how specific gene products, most notably repair, replication and recombination proteins, remove DNA damage or allow cells to tolerate DNA damage. Others identify novel lesions formed by DNA damaging agents and determine the extent to which, and the manner in which, known enzymes process those lesions in vitro. Still others stratify the biological importance of individual lesions, both in terms of lesion toxicity and mutagenic potential. We study the sequence of events triggered by toxin and toxicant exposure and ending in apoptosis. We also use transgenic mice infected with various pathogens to understand how inflammation can trigger disease in intact animals.

Core members:

John Essigmann (core director), professor, Biological Engineering Division and Chemistry
Peter Dedon, associate professor, Biological Engineering Division
Bevin Engelward, assistant professor, Biological Engineering Division
Leona Samson, professor, Biological Engineering Division
David Schauer, associate professor, Biological Engineering Division
Steven Tannenbaum, professor and co-director, Biological Engineering Division
Graham Walker, professor, Biology

Free Radical Chemistry and Biology Research Core

This core, directed by Professor Steve Tannenbaum, brings together CEHS members interested in understanding the chemical reactions of endogenous and environmental free radical species and the role of these processes in human disease. This highly interactive group is involved in interactive projects representing a program project grant

and two RO1 grants. Two major areas are covered: the role of NO in mutagenisis and carcinogensis; the chemistry and biology of ionizing radiation and reactive oxygen species.

Core members:

Steven Tannenbaum (core director), professor, Biological Engineering Division
Jeffrey Coderre, professor, Department of Nuclear Engineering
Peter Dedon, professor, Biological Engineering Division
Bevin Engelward, professor, Biological Engineering Division
John Essigmann, professor, Biological Engineering Division and Chemistry
James Sherley, professor, Biological Engineering Division
Gerald Wogan, professor emeritus, Biological Engineering Division
Jacquelyn Yanch, professor, Department of Nuclear Engineering

Molecular, Cell and Tissue Engineering Research Core

Directed by Professor Linda Griffith, the mission of the MCTE core is development of new tools for analysis of toxicological phenomena across a hierarchy of levels—molecules, cells and tissues—via a synthesis of biology with engineering. The primary focus of this team is characterizing interactions of agents with eukaryotic cells and tissues, with an ultimate objective of predicting how to prevent or mitigate the effects of existing toxicants humans are exposed to, and how humans will respond to putative new toxicants, such as drugs, herbicides, etc. One emphasis of the team is building new model systems, such as 3D tissues that replicate the physiology of the liver capillary bed, new mice that allow quantitative study of specific recombination events, stem cell lines that enable analysis of asymmetric kinetics of cell division, and methods of screening the impact of toxicants on entire metabolic pathways. A complementary focus is development of new instrumentation methods to measure the properties of events occurring at several levels. Projects in this area include measurement of the mechanics of DNA under physiological conditions associated with damaging events and multiphoton microscopy to analyze apoptosis in 3D cultures, and rapid scanning multiphoton spectroscopy to assess rare recombination events in vivo. The team is also developing quantitative engineering models for that incorporate data from the measurements.

Core members:

Linda Griffith (core director), professor, Biological Engineering Division
Peter Dedon, associate professor, Biological Engineering Division
Bevin Engelward, assistant professor, Biological Engineering Division
James Sherley, assistant professor, Biological Engineering Division
Peter So, associate professor, Mechanical Engineering

Research Core in Environmental Systems and Health

Directed by Professor Harry Hemond, the mission of this research core, is to understand, holistically, the relationships that link ecological processes and human health. Although this includes the now traditional "fate and transport" model (in which chemical releases are transported and modulated by processes in ecosystems, thus governing the extent of human exposure to the chemicals), advances of the past decade now mandate a broader view of environment/health linkages, in which genomics and ecology play an increasing role. Future advances will require better understanding of evolution, gene flow, and ecosystem processes along with progress in chemical and physical modeling and measurement. Gene flow, for example, can affect the distribution of pathogenicity, or the acquisition of antibiotic resistance or biodegradative capability in microbial communities. Ecosystem processes govern the nature of coexisting populations at scales from that of the gut to that of continents, with direct effects on humans at all scales.

This is an emerging field that cuts across traditional disciplines, and brings together researchers with expertise that includes but is not limited to environmental chemistry, ecology, microbiology, veterinary science, and environmental physics. A unifying theme is that of ecology in the broad sense; each project and researcher is involved with processes that occur in the natural environment, yet have implications for the well being of people. Increasingly, it can be seen that the well being of humans is inextricably interconnected with processes that may best be regarded as ecological, at all scales from planetary to cellular.

This area will become increasingly well defined, and recognized as critical to human health, in coming years. We want this core to contribute to the process. Examples of projects currently engaged by researchers in this core include: the environmental geochemistry of toxic metals, population dynamics of co-occurring pathogenic and non-pathogenic Vibrio species in natural waters, the ecology of the lower gut, the ecology and evolution of microorganisms in nature, and arsenic in drinking water in Bangladesh (a result of a tradeoff between chemical toxins and environmentally transported pathogens).

Core members:

Harry Hemond (core director), professor, Civil and Environmental Engineering
Sallie Chisholm, professor, Civil and Environmental Engineering
James Fox, professor, Biological Engineering Division

Charles Harvey, professor, Civil and Environmental Engineering
Heidi Nepf, associate professor, Civil and Environmental Engineering
Martin Polz, assistant professor, Civil and Environmental Engineering
David Schauer, associate professor, Biological Engineering Division

Signal Transduction Research Core

Directed by Professor Douglas Lauffenburger, the cell signaling core comprises a half dozen scientists and engineers undertaking collaborative projects with the goal of developing quantitative, integrative systems understanding of cell-cell communication and intracellular signal transduction.

Substantial collaborative projects exist as connecting "edges" between many of these "vertices", some of which are being pursued as a major multi-investigator DARPA-funded program in Cell Decision Processes aimed at deciphering the "information flow" governing death-versus-survival decisions in human blood and tissue cells confronted simultaneously by death-promoting and survival-promoting soluble factors. Among this class of projects are a Sorger-Lauffenburger-Tannenbaum collaboration on kinetic modeling of TNF -, EGF-, and Insulin-activated networks regulating caspase-mediated apoptosis processes and a Yaffe-Lauffenburger-Sorger collaboration on high-throughput quantitative protein kinase activity assays for generating dynamic data for vector state-space analysis of cue/signal and signal/response relationships. A nascent Lauffenburger-Samson collaboration extending the latter kind of systems approach to DNA damage activated death/survival decisions, and an analogous Yaffe-Sorger-Lauffenburger effort toward analyzing decision pathways activated by chromosomal segregation defects, are being built upon this foundation.

All of these collaborative investigations manifest the quantitative systems perspective catalyzed by our MIT biology/engineering fusion, and leverage funding support from other government agencies (including NIGMS, NCI, NSF, DARPA, and Army) as well as biotechnology and pharmaceutical companies.

Core members:

Douglas Lauffenburger (core director), professor, Chemical Engineering and Biological Engineering, co-director Biological Engineering Division
Ram Sasisekharan, associate professor, Biological Engineering Division
Leona Samson, professor, Biological Engineering Division
Peter Sorger, associate professor, Biology Department
Steven Tannenbaum, professor, Biological Engineering, co-director Biological Engineering Division
Michael Yaffe, assistant professor, Biology Department

Computation and Structure Research Core

The MIT Center for Environmental Health Sciences research core in computation and structure, directed by Professor Bruce Tidor, consists of both structural biologists and cell biologists with a wide range of expertise and areas of research interest. The unifying theme that brings this research core together is the development and use of computational tools to interpret and predict molecular structures and cellular behavior in response to exposure to environmental agents.

This newly formed research core already has a number of strong interactions and is expected to grow new links internally, with other research cores in the center, and with facilities cores of the center. Ellenberger's structural studies of DNA repair proteins involve extensive interactions with the mutation and cancer research core and the Free Radical Chemistry and Biology Research Core. Lauffenburger is director of the signal transduction research core and Sorger is co-director of the genomics, proteomics, and bioinformatics core facility. Tidor, Sorger, Lauffenburger, and Samson are on the executive committee of a new initiative in computational and systems biology at MIT, an umbrella program under development that leverages the expertise of a broad cross-section of the campus from different departments to foster research and education in this new and vigorous area. In general terms, joint students exist between members of the computation and structure core and almost every other research core in the center, while much of the computational and data modeling work will rely on data generated in other research cores, particularly so with the signal transduction research core currently. It is easy, however, to see the strengthening of other links facilitated through the center.

A significant portion of the computational and data modeling performed in this research core will make use of the resources of the genomics, proteomics, and bioinformatics core facility. Of particular importance here are Tidor's development of computational methods for informatics, Sasisekharan's glycoinformatics, Sorger's studies of cellular decision-making and Lauffenburger's cellular modeling studies. The work of structural biologists will benefit greatly from the bioanalytical core facility, with emphasis on the chemical analyses required for the studies performed by Ellenberger, Drennan and Sasisekharan. Finally, Sorger's imaging work will make use of the molecular and cellular imaging core facility.

Core members:

Bruce Tidor (core director), associate professor, Biological Engineering Division and Electrical Engineering and Computer Science
Catherine Drennan, assistant professor, Chemistry
Tom Ellenberger, professor, Harvard School of Public Health

Doug Lauffenburger, professor, Biological Engineering Division
Ram Sasisekharan, associate professor, Biological Engineering Division
Peter Sorger, associate professor, Biology

Core Facilities

Bioanalytical Core Facility

Co-Directors: Dr. Pete Wishnok and Dr. Koli Taghizadeh

Researchers who need extensive use of dedicated instruments will generally have these in their own laboratories. Situations often arise, however, where additional equipment is needed on a temporary basis, or where occasional use of a specialized instrument such as a mass spectrometer can't be justified. In other cases, researchers may need expert assistance in method development or experimental design. The bioanalytical core laboratories maintain an extensive collection of up to date major instruments, along with skilled and experienced scientists, to fulfill these needs.

Dedicated equipment (in Building 16):

- Agilent 5973 Benchtop GC-MS with electron ionization and positive and negative-ion chemical ionization
- HP 5973 Benchtop GC-MS with electron ionization
- HP 5973 Benchtop GC-MS with electron ionization
- Sciex API I LC-MS with electrospray and APCI ion sources
- Agilent LC-MSD single quadrupole electrospray system
- HP 1100 binary pumping system with diode-array, variable wavelength UV, and fluorescence detectors
- HP 1090 binary pumping system with diode-array and fluorescence detectors
- ISCO precision ternary syringe-pump system with diode array and variable wavelength UV detectors
- Perkin-Elmer preparative-scale LC system

Other equipment:

- Fourier Transform Infrared Spectrophotometer

Equipment available ad hoc via the Biological Engineering Division Mass Spectrometry Laboratory (in Building 56)

- Agilent 1100 Capillary MSD ion-trap mass spectrometer with electrospray, photoionization, nanoelectorspray, and atmospheric-pressure chemical ionization sources
- Agilent 1100 LC MSD single-quadrupole mass spectrometer with precision mass-based fraction collector. All the ion-sources listed above for the MDS Trap are compatible with this instrument.
- Applied Biosystems API 3000 tandem quadrupole mass spectrometer with electrospray, atmospheric pressure chemical ionization, and nanoelectrospray ion sources and a dedicated HP 1100 binary pumping system with diode-array detector
- Perceptive Biosystems Voyager Elite DE MALDI-TOF mass spectrometer with delayed extraction and reflectron

Other equipment includes several free-standing HP 1100 binary pumping systems with a variety of interchangeable detectors and modules including diode-array detectors, autosamplers, thermostatted column compartments, and a fluorescence detector; an automated desalting/column-switching system that can be used with any of the LC/MS systems; free-standing UV-vis spectrophotometer; SpeedVacs, etc. The lab contains a permanent facility for custom packing of capillary HPLC columns.

Equipment in each laboratory is connected to a local network for printing, data transfer and storage, and Internet access. As noted below, we are in the process of developing an inter-laboratory network.

The bioanalytical core is directed by the internationally renowned mass spectrometrist Dr. John S. Wishnok and co-directed by Dr. Koli Taghizadeh. Elaine Plummer, an experienced research specialist, is funded full time through CEHS. Joseph Glogowski, a technical specialist, is available ad hoc for software and hardware consulting.

The bioanalytical core will be used regularly by at least five of the research cores, i.e., signal transduction; radical chemistry and biology; mutation and cancer; molecular, cell, and tissue engineering, and environmental systems and health research cores. In addition, there will be developmental interactions with the accelerator mass spectrometry, the molecular and cellular imaging, and the genomics, proteomics, and bioinformatics core facilities.

The field of bioanalytical chemistry—especially in mass spectrometry—is in a period of extremely rapid development. We expect in the near future to acquire at least one high performance mass spectrometer, e.g., a quadrupole time of flight or a tandem quadrupole/linear ion-trap. The dedicated CEHS laboratories, including offices for Dr. Taghizadeh and Ms. Plummer, will move to new space within a year or so. To facilitate data exchange and communication, a web-based network is being developed by Mr. Glogowski for our current facilities; this should be operational by the time of the move, and should include secure but accessible data storage and real-time video conferencing.

Accelerator Mass Spectrometry Core Facility

Directed by Dr. Paul Skipper, the accelerator mass spectrometry (AMS) core provides ultrasensitive detection and quantitation of biomedical and other organic samples that have been isotopically labeled with ^{14}C or tritium. Research that involves such samples is anticipated to cover a broad range of interests, having in common the need to detect extremely low amounts of isotope deliberately introduced into the system of interest by the investigator. The AMS instrument is central to this core since there are very few available worldwide and most are dedicated to non-biomedical applications. The AMS also provides a unique service and expertise in integrating AMS detection with conventional (GC, HPLC, multi-well plate) bioanalytical instrumentation.

Equipment

The principal instrumentation is a compact, low energy AMS that was designed and constructed by Newton Scientific, Inc., and installed and brought on line at MIT. From the beginning, this instrument was intended to be operated as a bioanalytical instrument, with connections to chromatographic and other sample purification and separation systems. This operational mode distinguishes it from other AMS instruments, which accept samples only in isolated solid—or, rarely, gaseous—form. The AMS has been operational for approximately two years and undergoes a continuous process of evolution and upgrading. At present, the detection limit for ^{14}C is 10^{-18} mole in samples with ^{14}C:^{12}C isotope ratio of 10^{-10}.

Major commercially available equipment includes an HP5890 gas chromatograph, which will soon be equipped with a Thermal Desorption System for injecting trapped gas samples, and an Agilent 1100 capillary HPLC. Both of these have been interfaced to the AMS as described below.

The GC column output is directed into a CuO reactor that oxidizes samples as they emerge from the column to produce CO_2 from the sample carbon. CO_2 is then transported in a carrier gas stream into the AMS ion source for analysis. This interface is based on previously described designs used for isotope ratio gas chromatography-mass spectrometry. It incorporates unique features needed for successful operation with AMS.

For introducing non-volatile samples, we have developed an interface based on laser-induced combustion for rapid conversion of organic carbon to CO_2 and subsequent transport of the CO_2 formed into the ion source of the AMS, thereby eliminating the conventional graphitization process used to produce solid samples. Sample is applied to a layer of CuO catalyst deposited in a refractory support. Volatile solvent is removed by evaporation. The catalyst plate is then translated through a reaction chamber in which it is irradiated by an infrared laser beam. Localized heating of the catalyst layer by the laser induces combustion of sample carbon to CO_2. A constant flow of He removes the CO_2 directly from the site of formation and transports it to the AMS ion source. Individual samples are irradiated in sequence for AMS analysis independently of the other samples present. Applicability of the same system for analysis of HPLC has also been demonstrated. Instead of applying individual samples at different locations on the catalyst layer, HPLC eluent is applied continuously to the bed as it moves past a deposition point at a constant rate. The overall process preserves the essential features of the chromatogram.

A prototype interface for tritium-labeled samples has also been designed, fabricated, and tested. This interface is based on pyrolysis, rather than combustion chemistry, and accepts solution samples without desolvation. Because it is designed for very small samples, its ultimate applicability is expected to be to high-throughput, micro array-based sample processing.

Since this core is being newly established, in the immediate future it will focus on the activities for the various Center investigators. Longer term, there are other directions already being pursued. We currently have a grant proposal under review that would fund the design and construction of a new, tritium-only, combination AMS instrument/high throughput interface. The design philosophy behind this combination is to produce an instrument that is capable of high resolution, rapid interrogation of tissues and sample arrays derived from experiments utilizing lower-cost and more readily accessible tritium-labeled compounds. There will also be a continuing program of hardware and software upgrades to the existing AMS instrument and interfaces. There is an interest on the part of Professor Tannenbaum to expand his research into single-cell metabolism studies by detection of metabolic $^{14}CO_2$ in microfluidic devices.

Genomics, Proteomics and Bioinformatics Core Facility

The MIT Center for Environmental Health Sciences research core in Genomics, Proteomics and Bioinformatics is co-directed by Professor Peter Sorger and Dr. Rebecca Fry and is integrated into the MIT BioMicro Center. The BioMicro Center was established in 2000 to acquire and operate robotic instrumentation for microarraying and computer systems for bioinformatics, and to provide core services in these areas. It is a joint endeavor of the Center for Environmental Health Sciences, Department of Biology, Center for Cancer Research and Biological Engineering Division. The BioMicro Center aims to provide an integrated facility for microarray fabrication, microarray analysis, database storage, data mining and data modeling.

For users to derive accurate and meaningful microarray data in a timely fashion, it is essential that fabrication and

computational services be supported with a high standard of excellence. This in turn requires a professional staff of research scientists and strong oversight committees. The BioMicro Center currently has a staff of seven, three of whom are devoted to array technologies and four to information technology. Day to day operations of the BioMicro Center are supervised by Peter Sorger, director, and center policies set by an executive committee comprising of Leona Samson, Doug Lauffenburger, Bob Sauer and Tyler Jacks.

The BioMicro Center is currently being relocated to newly refurbished labs on the third floor of the Koch Biology Building. Computing clusters are also being set up in building 56 and the Cancer Center. The BioMicro Center aims to support genomics, informatics and microarray research in six key areas:

- Integrated support for Affymetrix GeneChips and Spotted Microarrays—The BioMicro Center supports the routine production and custom fabrication of spotted DNA microarrays based on oligos and cDNA and will also support Affymetrix GeneChips. It seems almost certain that both spotted arrays and GeneChips will be important for expression profiling experiments over the next few years. Spotted microarrays have the advantage of lower cost and greater flexibility. GeneChips are becoming increasingly important when whole-genome coverage is needed. Currently, human, mouse and yeast spotted arrays are available from the core for a cost of $75–$150 each.
- Strong three tier architecture for data storage and processing—Expression profiling can be performed on a small scale using spreadsheets and desktop applications. As the amount of data increases however, it is essential to use databases. The BioMicro Center has installed several three tier client/server systems based on open source and commercial database management systems (DBMS). These systems will be strengthened and extended to achieve integrated support for GeneChips and spotted microarrays.
- Network of managed desktop computers for data analysis and mining—The BioMicro Center has licensed commercial software including the Affymetrix MAS-DMT suite and Spotfire Decision Site for basic analysis of microarray data. The number of licenses will be increased and open-source tools will be integrated into the three tier BioMicro IT system. Client software will then be deployed on a network of managed desktop computers based on the MIT Win-Athena and Linux-Athena environments. The desktop network will provide a distributed system of analysis software tightly integrated to a high-reliability data storage infrastructure.
- Training and educational program in commercial and open-source bioinformatics software—A program of professional training seminars for commercial software will be strengthened and supplemented with seminars taught in-house for open source software.
- Technical assistance with programming, DBMS administration and data analysis—Additional staff is currently being hired to provide a strong capability in programming and database customization. Bioinformatics applications that currently operate separately from each other will be integrated.
- Quality control, error modeling and new technologies introduction—Rebecca Fry is overseeing the development of data models and quality control procedures for DNA microarray analysis. Error models will be integrated into a comprehensive Bayesian informatics chain. The introduction of new devices and computational methods will be accelerated through close collaborations between biologists, engineers and computer scientists throughout MIT.

In the area of microarraying and bioinformatics, the immediate goal of the BioMicro Center is to fully implement a database driven workflow for the analysis of spotted and Affymetrix gene arrays. This will include completion of our Oracle-based databases for array data, the integration of desktop software with these databases, and the installation of managed clusters of desktop computers for running software. Substantial completion is expected by fall 2002.

In the area of high performance computing, the BioMicro Center is currently installing a 64-processor Beowulf cluster computer and has funds to expand to 128 processors. This system will be complemented by a new 6TB-class data storage system and a gigabit ethernet network. The Beowulf system is on order and the Bio-SAN network is currently being installed. Support for high performance cluster-based computing will be in place by late summer 2002 and is made possible by a grant from the NSF.

In the longer term, the BioMicro Center intends to link its fabrication facilities with the MIT Microsystems lab and the rapid prototyping lab in the Media Lab. This will assist in the development of new devices combining proteins and DNA with microfabricated devices.

The Molecular and Cellular Imaging Core Facility

The Molecular and Cellular Imaging Core, directed by Dr. Elena Gostjeva, will be a crucial resource for CEHS researchers. State of the art molecular and cellular imaging is absolutely required for today's biological research, and research in the Environmental Health Sciences is no exception. In particular the ability to measure the influence of environmental agents on genetic, biochemical and biological processes in cells—whether in single celled cultures or multicellular tissues —is crucial for much of the research carried out by CEHS faculty. One goal of the core

is to provide molecular cytological analysis that includes the best solutions in visualization and measurement of microscopically detectable objects within diverse biological systems. The development of automated programs that would speed up scanning, counting and measurements of specific biological targets will be pursued. The overall objectives of this core are: to provide training in sample preparation, and training in the efficient use of the available instrumentation, for all CEHS members and their students, postdocs and staff; and to develop new imaging methods and analytical tools.

Sophisticated microscopes and sensitive imaging instrumentation are required for monitoring the presence and location of proteins in cells and tissues (using immunofluorescence or fluorescently tagged proteins), for monitoring the induction of damage to chromosomes (cytogenetics), for monitoring the induction of cell death by apoptosis or necrosis, for monitoring the induction of cell cycle checkpoints, and for monitoring pathological changes in cells and tissues. All of these endpoints can be altered or triggered in response to environmental agents. The Molecular and Cellular Imaging Core is fairly well equipped for measuring each of these endpoints. The currently available instruments, and those that we plan to incorporate in the future are detailed below.

Current equipment:

- Nikon Eclipse E800 fluorescence microscope, comprising four Nikon objectives (Plan Fluor 10x fluorescence; Plan Apo 60x achromatic; Plan Apo 100x achromatic), a 100W Hg Epifluorescence Arclamp, an Optronics cooled color CCD camera with DEI-750 digital image processing electronics, 4 filter blocks, and an Apple Power Macintosh 8600/200 computer with Scion Corp. CG-7 Frame Grabber video capture card
- Nikon Labophot fluorescence phase-contrast microscope, comprising 7 Nikon objectives (10x, 20x, 40x, and 100x phase-contrast; 40x and 100x fluorescence; Plan Apo 100x achromatic), a 6-position phase ring with darkfield setting, 5 filter blocks, 100W Hg Epifluorescence Arclamp; Nikon 35mm camera and Nikon AFX exposure control apparatus
- Zeiss fluorescence phase-contrast microscope, comprising 5 Zeiss objectives (10x, NEOFLUAR 25x, 40x, and 100x fluorescence phase-contrast; and Planapo 63x achromatic), a 100W Hg Epifluorescence Arclamp, a 35mm camera and a Zeiss MC63A exposure control apparatus
- CompuCyte LSC Laser Scanning Cytometer, comprising a HeNe laser, 3 filter/photomultiplier tube units, cytometer, an Olympus BX50 fluorescence microscope with proprietary modifications, 3 UPlanFluor fluorescence objectives (10x, 20x, 40x) a black-and-white CCD camera with CRT display, a color 3-CCD camera with CRT display, 3 filter blocks, an HP Vectra VL computer with proprietary data acquisition and image capture components
- Zeiss phase-contrast microscope, comprising 4 Zeiss objectives (10x, 25x, NEOFLUAR 40x fluorescence phase-contrast, 100x), 4-position phase ring with darkfield setting
- Bausch & Lomb dissecting microscope
- Zeiss Axioskop 2 MOT fluorescence phase-contrast microscope, comprising 3 Zeiss objectives (Plan NEOFLUAR 10x and 20x fluorescence, Plan Apo 100x achromatic); phase-contrast, darkfield, and DIC optics; precision motorized stage and focus controls with MCX-2 high resolution positioning controller; 3 filter blocks; 100W Hg epifluorescence arclamp; and a Zeiss AxioCam color, ultra-high resolution (3900 x 3090 pixels) digital camera connected to a PC workstation

Future purchases that are currently under discussion include a Molecular Dynamics Typhoon Phosphorimaging instrument for detection, imaging and quantitation of radioactive, chemilluminescent and fluorescent molecules. In addition, CEHS members have requested that instrumentation for laser capture microscopy (LCM) be added to this core facility and, should there be enough demand for such a capability, we will act upon this request.

The ultimate goal of the molecular and cellular imaging core is to enable researchers in the labs of the CEHS faculty to apply cutting edge microscopy and sophisticated imaging in their quest to determine how environmental agents perturb biological systems. This type of analysis, i.e., at the tissue, cellular and subcellular levels, dovetails perfectly with the kind of information obtained by the bioanalytical core facility and the genomics, proteomics and bioinformatics core facility. Dr. Elena Gostjeva has fifteen years of experience in light microscopy and cytogenetic analyses of various different types of chromosomes. Her extensive experience with state of the art microscopes and advanced digital imaging methods prepares her well to be director of this core. Use of the aforementioned instruments will be overseen by Dr. Elena Gostajeva, and she will train lab members of the CEHS faculty in the methods required for preparation and analysis of biological materials for immunohistochemistry, cytogenetics, cytotoxicity and other related microscopy and imaging methods. Unfortunately she is only able to commit 30 percent of her time to this endeavor, and we therefore plan to recruit a co-director for this core. Our plan is to appoint a co-director who will specifically interface between the CEHS molecular and cellular imaging core and a number of other imaging cores at MIT that also offer sophisticated light microscopy facilities. In this way we hope that the imaging cores on campus will co-ordinate their purchases and avoid needless duplication.

For future core capabilities we plan to develop the following:

- automated labeling/counting of apoptotic cells in human cell cultures and tissues
- measurement of DNA damage through yeast cells comet assay
- automated program of 2D images deconvolution in a very small size objects (on a range of about 0.1 um, 4 x 10^5 – 1x10^4 DNA base pairs length) using yeast mitotic chromosomes as a model;
- standardization of the image analysis with regard to measurement of eukariotic cell nuclei sizes and DNA contents (internal standard for visual image cytometry approach)

With the assistance of the Zeiss Company we also hope to develop the following:

- to establish the best resolution in microscope phase contrast imaging of non-stained cells (lenses versus image deconvolution programs): excellent for the study of morphology and architecture of cells, nuclei and chromosome structures; the application area: apoptotic cells, genomic instability; structural chromosome rearrangements.
- to establish the best imaging resolution of multiple stained cells, FISH stained chromosomes and chromosome structures, anti-body stained proteins; possible application area: study of the genetic apparatus damage at the level of large-scale chromatin.
- To probe the PALM Laser-MicroBeam system (micro-tweezers) to catch and move a single cell, a cluster of cells from the microscopic slide into a tube for molecular analysis; possible application area: stem cell specific mutations; cell-specific gene expression analysis in living tissues.

These methods are thought to be of importance as they might fill the gap between studies at molecular and cytogenetic levels in understanding how environmental agents interact with the living cells on a pathway to human disease.

Community Outreach and Education Program

The Community Outreach and Education Program (COEP) program is directed by Professor Heidi M. Nepf, who collaborates with Amy Fitzgerald, director, Edgerton Outreach Program, MIT. In a recent speech entitled, "Science as Patriotism," NSF Director Dr. Rita Colwell stressed both, "the primary importance of a scientifically literate citizenry," as well as, "the responsibility of the science and engineering community to meet that goal." Dr. Colwell went on to give this recent example of how misinformation can breed chaos and hysteria. During the anthrax scare many public officials and private citizens believed that the disease was contagious—a misconception that exacerbated public stress. Perhaps more compelling are the daily decisions faced by citizens, from personal health care to community development, which require the interpretation of scientific information. Finally, the level of scientific literacy of high school students greatly influences the pipeline of young talent entering the scientific and engineering workforce upon which our technological society depends. The goal of the MIT COEP is to promote of scientific literacy with a variety of projects targeted to students in grade four through undergraduate. In addition, the MIT COEP mentors young scientists on the mechanisms and importance of educational outreach by supporting the participation of undergraduate and graduate students in the development and implementation of outreach activities.

Highlights From COEP Activities

Collaboration with MIT's Edgerton Center

Through hands on activities, the Edgerton Center invites students to be scientists for a day. This past year the center hosted 2000 students from public schools and community groups. To take advantage of its infrastructure, COEP bought into the Edgerton Program, beginning in 2001, by supporting one- quarter of the program director's salary. Working with the director, Amy Fitzgerald, and with guidance from the Cambridge Public School teachers, we developed a new activity, Grungy Groundwater, that challenges students to discover how water and pollutants move underground, and how pollutants can impact drinking supplies. Students first explore how fluids travel through different soil types. Then, students build their own models of the underground using different soil types. The students use their models to discover how buried and surface contamination enter and travel through the subsurface. The session ends with a discussion of how a community might respond after discovering contamination in their drinking wells.

During the past year the activity was tested and edited by a group of Cambridge Public School (CPS) teachers and students. The activity will be a formal offering of the center starting next school term (fall 2002), and we expect about 500 students per year will take part. In addition, with cooperation from the CPS Science Coordinator, Dr. Melanie Barron, we hope to integrate this activity into the pollution and ecosystem health unit of every 5th grade class in the CPS system. A video of the Grungy Groundwater Model in action is available at http://web.mit/edu/edgerton/outreach/ACT_GAG.html/. With the successful launch of Grungy Groundwater, we have just begun the development phase of a second activity.

More information about the our collaboration with MIT's Edgerton Center can be found online at http://web.mit.edu/edgerton/outreach/out.html/.

Video and Curriculum Development

Working with educational consultant Dr. Francesca Casella, COEP created a curriculum package on groundwater pollution and the Superfund program. The video walks students through the investigation of a contaminated site and the process by which a site is added to the National Priorities List. A curriculum guide outlines supporting activities such as hands-on experiments, web-based learning exercises, and suggestions for library and community research. For example, students are asked to query environmental databases to identify existing Superfund sites in their community and to research major pollutant inputs in their area and their potential health hazards. To help teachers integrate this package into the curriculum, the guide contains a chart mapping each activity to the National Science Education Standards. Initially the package will be disseminated through the NIEHS COEP Resource Center, directed by Karalyn Colopy, and through the Teacher as Scholars Program (see below). Portions of the video have already been adopted by the Advanced Technology Environmental Education Center (ATEEC) for use in a new curriculum for junior college students.

Teachers as Scholars Program

Teachers as Scholars is a K–12 teacher education program run jointly by Harvard and MIT. Selected teachers are invited to campus for seminars led by university faculty. Professors Culligan and Nepf host an annual a three day course, "Pollutant Transport in Natural Water Systems," that includes hands on laboratory activities. Teachers are encouraged to incorporate aspects of the seminar into their own curriculum. COEP facilitates this by providing advice, supplies and technical support to recreate all or part of the experiments for individual schools. For example, we adapted one of the laboratory exercises for Rebecca Green, a 7th grade teacher from Belmont Public Schools. We also developed an original water sampling activity for Jenn Morrell, a 6th grade teacher from Cambridge Public Schools. More information about the Teachers as Scholars Program can be found online at http://www.teachersascholars.org/.

Pilot Program

The Pilot Program is being reorganized, and we have currently a request for proposal advertised to encourage faculty across the Institute to submit a proposal. We expect to fund five proposals in the coming year.

Leona D. Samson, Director, American Cancer Society Professor, and Professor of Toxicology
Peter C. Dedon, Deputy Director and Associate Professor of Toxicology

More information about the Center for Environmental Health Sciences can be found online at http://web.mit.edu/cehs/.

Clinical Research Center

The Clinical Research Center (CRC) was established in 1964, with grant support from the National Institutes of Health (NIH), to provide a facility in which MIT investigators and their collaborators could apply the Institute's expertise in basic biochemical and biophysical mechanisms to the analysis of normal and pathologic processes in humans. MIT's CRC was the first federally supported clinical research center located in a university and not within a hospital, and remains one of only two or three such centers. It was anticipated that in spite of its university venue, a large number of qualified physicians and clinical scientists from MIT's faculty and staff would utilize the CRC to study normal volunteers, or patients with chronic diseases.

Scientists and physicians authorized to carry out research protocols using the CRC's facilities include professors, research scientists who work exclusively at MIT, and those with primary appointments in local medical institutions whose research interests overlap extensively with those of MIT investigators. Research protocols must be approved by the MIT Committee on the Use of Humans as Experimental Subjects (COUHES) and the CRC Advisory Committee before they can be implemented. The CRC Advisory Committee, chaired by Dr. Daniel Shannon, professor of pediatrics at the Harvard Medical School and professor of health sciences at the Harvard/MIT Division of Health Sciences and Technology, consists of ten voting members plus nine non-voting members from the CRC's program and operating staffs. The committee has reported to the principal investigator of the CRC's NIH Grant, Martha Gray, professor and co-director of Harvard/MIT Division of Health Sciences and Technology (HST). With the CRC's administrative merger with the Massachusetts General Hospital's CRC, it now reports (for NIH grant purposes) to Dr. James Mongan, principal investigator of the joint NIH grant. It meets bimonthly to evaluate protocols for their scientific quality, experimental design, ultimate statistical validity and potential risk to human subjects. The committee also sets general policies and reviews the operations of the CRC.

Administration

The CRC presently has a dual administrative locus within MIT. As a research unit, the CRC reports through the Harvard-MIT Division of HST to the vice president for research and associate provost, Professor Alice Gast. However, as a patient-care unit, the CRC is a part of the MIT Medical Department and reports to Dr. William M. Kettyle, the director of the Medical Department. Members of the CRC participate in the Medical Department's activities—e.g., its quality improvement, pharmacy and therapeutics, medical records, and safety committees.

Several years ago the CRC was approached by the General Clinical Research Centers administration of the NIH, which funds this and all other CRCs, and asked to consider becoming a "Network" CRC. This would involve implementing at the MIT CRC some research projects generated at other local CRCs, and, conversely, implementing some of our projects (e.g., those involving very sick patients) at those other centers. Additionally, the CRC would, where possible, coordinate the activities of the core laboratories, nutrition programs, and nursing programs with those of other local institutions, in order to increase their efficiency. The CRC would also use this networking as a platform from which to solicit additional NIH funds, perhaps as a part of a common grant. As a consequence, the CRC has for several years been developing a more structured relationship with the CRC at the Massachusetts General Hospital (MGH), and this expanding relationship has, in fact, been highly successful. To date, thirty MGH protocols have been approved and implemented at the MIT CRC, and three MIT protocols have been implemented at MGH. The senior program staffs at the two institutions continue to meet monthly to anticipate and solve potential problems related to their gradual integration and to streamline the protocol review process; COUHES and its MGH counterpart also work together to evaluate network protocols from the standpoint of safety.

The relationship between the two GCRCs continues to develop and expand. The two centers successfully collaborated on a joint NIH renewal grant application, for five years of support, to start funding in December 2002, when the present MGH NIH grant expires. The score, which the application and site visit received, was the best MIT has received on a five-year renewal. In addition, since the present MIT grant expired November 30, 2001, MGH and MIT jointly submitted an application for one year of funding for the MIT CRC (December 2001 through November 2002) as a dedicated supplement to the MGH grant and the NIH has funded this joint application for the present year. MIT is identified as a "satellite" to the MGH CRC, but will suffer no loss of "sovereignty" or autonomy and, based on discussions with the NIH, no decrease in funding.

Developing this type of "network" relationship with the MGH CRC allows the MIT CRC to solve a chronic problem, i.e., the small and shrinking pool of medical doctors conducting clinical research in this facility, a consequence of the failure, during the last decade, of MIT's academic departments to appoint such people as professors. Most important, it guarantees the longevity of the CRC until such time as the pool again expands, and provides a source of physician scientists to collaborate with MIT biomedical scientists who hold doctoral degrees. The reputations of the two CRCs apparently are excellent, and the strengths of each institution complement those of the other. The CRC also continues to "network" with other Boston-area GCRC's (e.g., BIDMC) and all interested parties agree that the CRC should continue to do so in the future.

Education

The MIT CRC provides formal training in clinical investigation to advanced postdoctoral fellows taking a graduate degree (in clinical research) at Harvard Medical School, and to individual postdoctoral (medical) fellows working with CRC principal investigators and other researchers. These fellows and students utilize the CRC's facilities to initiate research protocols and participate in ongoing projects supervised by senior investigators and faculty. (See section on the Center for Experimental Pharmacology and Therapeutics). The MIT CRC also affords opportunities to MIT undergraduate and graduate students to participate in clinical research projects. In addition, in the spring semester of 2002, Dr. Ravi Thadhani, an assistant program director, taught a formal undergraduate course in clinical investigation. The course was so well received that the decision was made to offer the course again in the spring semester of 2003.

Affirmative Action

The hiring of women and minorities continues to be a high-priority commitment of the CRC. The CRC does have one continuing problem in meeting affirmative action objectives—i.e., attracting qualified minority members. The traditional means of locating such personnel, by advertising and posting positions in local colleges, universities, medical institutions, and minority organizations, have not generated a significant response. Of the seven visiting scientists and scholars appointed by the CRC in AY2002, two were women and one was a minority. The CRC will continue its efforts to increase the pool of qualified minority applicants, as positions become available.

The CRC has been successful in recruiting women and minorities as study subjects. During 2001 approximately 51 percent of all study subjects were women and 11.5 percent of the total study population were black, 5.2 percent Asian, 7.4 percent Hispanic and .4 percent American Indian.

Research Activities

The CRC continues to maintain major commitments to the research activities associated with three clinical areas, each led by a senior professor. These areas are nutrition/metabolism (Vernon R. Young, professor, MIT School of Science), an area in which the CRC constitutes the major locus of MIT's activity, and one that is a traditional component of clinical research centers; neurochemistry/neuropsychopharmacology (Richard J. Wurtman, Cecil H. Green distinguished professor and program director, MIT CRC), which studies the effects of drugs, foods and hormones on brain composition and behavior, the effects of melatonin on sleep, and a set of diseases

characterized by affective and appetitive symptoms (i.e., depression, premenstrual syndrome, smoking withdrawal, carbohydrate craving, and obesity), which seem to relate to brain serotonin; and behavioral neuroscience (Emilio Bizzi, Eugene McDermott professor in the brain sciences and human behavior and Lee H. Schwamm, associate professor of neurology at the Harvard Medical School) and neuroendocrinology (Steven K. Grinspoon, assistant professor of medicine at the Harvard Medical School, and Anne Klibanski, professor of medicine at the Harvard Medical School). The behavioral neuroscience component now focuses on strategies for accelerating the return of various brain functions in people who have suffered strokes; the neuroendocrinology component focuses on neuroendocrine concomitants of AIDS, pituitary malfunction, and gender-dependent changes in calcium metabolism.

Groups collaborate on multidisciplinary projects, e.g., obesity, depression, and Alzheimer's disease. The scope of the CRC's activities has expanded broadly: In the past year it also supported research protocols involving, for example, toxicology, pediatrics, psychopharmacology, women's health, HIV, biomedical engineering, and diabetes. Reflecting its evolving interactions with the MGH GCRC, 35 of these projects (out of a total of 67) were directed by investigators whose primary appointments are at the MGH.

During AY2002 the CRC patient census totaled 1,493 outpatient visits and 40 inpatient days. The CRC branch of the NIH had provided, based on prior year's activities, support for up to 2,500 outpatient visits and 84 inpatient days. The decreased census could be explained by the completion of the data-gathering portions of several large projects.

Center for Experimental Pharmacology and Therapeutics (CEPT)

The HST Center for Experimental Pharmacology and Therapeutics (CEPT), based in the MIT CRC, has both an educational and research mission. This center is directed by Dr. Robert Rubin (HST), Osbourne professor of health sciences and technology. Educationally, each year 10 MDs, who have completed their clinical training, enter a two-year program that provides both hands-on research experience and didactic training in clinical investigation and experimental pharmacology. At the end of the two years, after passing a qualifying examination and fulfilling a thesis requirement, the graduates receive a master/medical science degree in clinical investigation from HST. A parallel program for PhD scientists is being established as well. This will involve HST, the Sloan School, the Department of Biology, and the School of Engineering, and will again be centered in the CRC. Research-wise, the emphasis of the CEPT has been in the application of positron emission tomography, magnetic resonance imagery, ultrasound and other measurement technologies to the development of new drugs. With the development of imaging at MIT, these technologies will be greatly facilitated.

Computer Facility

The CRC computer facility provides hardware and software support for the CRC staff and investigators and statistical assistance to all researchers. The computer staff continues to develop and upgrade the CRC Operations System with the addition of computer systems for the CRC and investigators. These systems use an ORACLE relational database, which supports the day to day operations of the CRC. The computer staff has also been working with their MGH counterparts to maintain and upgrade the Turbo software package, which has streamlined the protocol application process and NIH annual reporting requirement for both CRCs. In addition, considerable time and effort continues to be spent updating and improving the CRC web site by adding links for MIT IRB protocol applications and expanding the interactive format for the MIT online protocol process. Researchers also continue to make use of the SAS statistical software available on the CRC computer system.

Core Laboratory/Mass Spectrometry Facility

The Core Laboratory specializes in assays that directly support the research efforts of CRC investigators and are not readily available commercially. The most important and complex assays are undertaken by the Mass Spectrometry Facility, where stable isotope tracer analyses are performed. The Mass Spectrometry Facility is a shared instrument facility that allows CRC investigators to conduct human metabolic studies using stable nuclide tracers. Principal areas of investigation concern the regulation of energy substrate metabolism in health and disease, and the regulation of whole body amino acid metabolism, with particular reference to the nutritional requirements for indispensable and conditionally indispensable amino acids. Research at the MIT CRC has made important contributions to the further development of national and international dietary standards and the establishment of sound food and nutrition policies and programs. Studies continue to examine the role of dietary arginine as a precursor of the signal transducer nitric oxide. The novel doubly labeled water ($2H_2{}^{18}O$) method is being used to define the energy requirements for adolescent and elderly subjects, and the factors, which affect these needs. These various investigations offer new basic knowledge about the physiology of human energy substrate and amino acid metabolism and, additionally, make practical contributions to problems in human nutrition.

The Core Laboratory also utilizes high performance liquid chromatography (HPLC) techniques. A Beckman System Gold Amino Acid Analyzer HPLC provides resolution of up to 42 physiologic amino acids. Other HPLC assays include tests for choline, tryptophan, the catecholamines, cytidine and melatonin.

Research Highlights

Dr. Linda Bandini

Dr. Linda Bandini and her colleagues have continued their longitudinal study of the effect of energy expenditure on growth and development in pre-adolescent girls. Annually, subjects visit the CRC for measures of height, weight, and anthropometric measures. In addition, they complete questionnaires regarding their activity and dietary patterns. The study is completed four years after menarche: at study completion the body composition and metabolic rate of the girls are measured in addition to their annual measures. As of June 30, 2002, 154 girls have completed the longitudinal study and only one remains active in the study.

This study will allow the investigators to determine whether reductions in daily energy expenditure or any component of energy expenditure is a risk factor for the development of obesity in adolescent girls. Recently, an article concerning the results of this study entitled "Relationship of Body Composition, Parental Overweight, Pubertal Stage, and Ethnicity to Energy Expenditure Among Premenarcheal Girls" was accepted by the *American Journal of Clinical Nutrition*.

Dr. Bandini is also investigating the relationship of visceral fat to diet, activity, and hormonal changes in a sub cohort of 40 girls. In this sub cohort, abdominal scans were done at menarche to measure visceral fat and, in these girls, visceral fat is again measured at study completion. These studies will provide information on variables that may influence visceral fat deposition. Determining what factors influence the deposition of visceral fat will provide useful information for the prevention of diabetes and heart disease.

Dr. S. Grinspoon

Dr. Grinspoon and his group have continued to investigate the pathogenesis, clinical phenotype and treatment for HIV lipodystrophy and related metabolic and body composition disorders associated with HIV disease. The HIV lipodystrophy syndrome is a novel metabolic syndrome, characterized by insulin resistance, dyslipidemia and significant changes in fat distribution. Dr. Grinspoon initiated an important collaboration with the Framingham Heart Study to quantify the degree of cardiovascular risk and determine the prevalence of metabolic abnormalities in the HIV lipodystrophy population, demonstrating that almost 45 percent had impaired glucose tolerance, compared with age and BMI-matched patients of the Framingham Offspring study.

Demonstration of significant hyperinsulinemia prompted the first randomized placebo-controlled study of metformin in this population. Results from this study, published in JAMA, showed that metformin treatment could significantly reduce insulin resistance, waist circumference, blood pressure and markers of impaired thrombolysis.

In collaboration with Professor Vernon Young of MIT, Dr. Grinspoon and his group have demonstrated increased lipolysis and a potential role for increased FFA in mediating the insulin resistance. Acute administration of acipimox to such patients doubled insulin sensitivity and decreased FFA. Ongoing MIT GCRC studies, in collaboration with Dr. Colleen Hadigan, are also investigating the utility of dietary manipulation and exercise. Taken together, the studies of Dr. Grinspoon and his group have substantially advanced the understanding of mechanisms causing, and potential treatments, for insulin resistance in HIV lipodystrophy.

Dr. Richard Wurtman

Dr. Richard Wurtman and his colleagues have continued to examine the effects of drugs, foods and hormones on brain composition and behavior. Three sets of pharmacokinetic studies have been performed on compounds, which may subsequently be used to study behavioral or physiological mechanisms. These are: melatonin: an additional study was performed on both 0.3 and 0.6 mg doses, preparatory to a planned multicenter study on the hormone's sleep effects; 5-hydroxytryptophan (5HTP): studies were performed to confirm that it is normally found in the blood, and that administration of low doses without a decarboxylase inhibitor produces dose related increases in plasma 5HTP levels. The compound's effects on stress induced eating will now be studied; uridine monophosphate (UMP) studies are underway to determine whether its oral administration causes dose related increases in plasma uridine levels. If so, studies are planned to see whether it protects against age related memory loss in humans — as it appears to do in rats.

Dr. V. Young

Dr. Young and his colleagues have continued to explore the quantitative aspects of amino acid metabolism in healthy adult humans, with particular reference to their nutritional corollaries. Studies have been completed to the effects of a sulfur amino acid-free diet on whole blood glutathione (GSH) synthesis, showing that GSH production is regulated by the dietary availability of one of its precursors, cysteine. Studies have also been completed on the kinetics and urinary excretion of L-5-oxyoproline, an intermediate of the gamma-glutamyl cycle of GSH synthesis. Both sulfur amino acid-free and glycine-free diets alter the dynamics of oxoproline metabolism and increase the urinary excretion of this intermediate which may, therefore, serve as a potential probe of the status of GSH metabolism in human subjects. Studies have also continued on the kinetic aspects of amino acid metabolism in particular adults. Studies with lysine and threonine as the test amino acids again confirm the hypothesis that the current international requirements values for the indispensable (essential) amino acids in healthy adults are far too low and that the tentative MIT amino acid requirement pattern is an appropriate one for use in practical considerations of adult human protein and amino acid nutrition. These findings and conclusions have

major significance with respect to the planning of diets and an evaluation of diets for their amino acid adequacy worldwide. They also have important implications with respect to the planning of agricultural research programs that are directed toward improving the nutritional quality of foods in humans.

Richard J. Wurtman
Director

More information about the MIT Clinical Research Center can be found on the web at http://web.mit.edu/crc/www/.

Division of Comparative Medicine

The Division of Comparative Medicine (DCM) provides animal husbandry and clinical care for all research animals on the MIT campus. From its inception in 1974, the division has evolved into a comprehensive laboratory animal program that provides a full range of veterinary and surgical support. Additionally, the division has a National Institutes of Health (NIH) grant for training veterinarians for careers in biomedical research. The division also has an active research program funded by numerous R01 grants from NIH. Total personnel in the division now comprises 118 individuals. The division's administrative headquarters along with diagnostic and research laboratories are located on the eighth floor of Building 16. This space is contiguous to the eighth floor of Building 56, which houses quarantine, diagnostic and research space for DCM. The division now encompasses approximately 115,000 square feet devoted to animal research activities. In addition a new vivarium is being planned for the new neuroscience complex.

Facility Management and Animal Care

The average daily census of laboratory animals remained stable during FY2002. Mice remain the primary species used by MIT investigators and represent more than 97 percent of the animal population. The animal facilities support transgenic and gene "knockout" in vivo experiments. DCM now operates a transgenic core and performs a range of transgenic services including in vivo embryo transfer for rederivation of mice with endemic disease which have been imported to MIT from laboratories worldwide, in vitro fertilization, the provision of blastocysts, genotyping of mice and the making of genetically engineered mice. The division has begun to develop expertise in aquaculture and now provides veterinary support for the large zebra fish colonies maintained at MIT. The division received a $660,000 grant from NIH for Improving Institutional Animal Resources. The grant will partially pay for physical improvements to the E25 animal facility as well as the acquisition of additional primate caging and ventilated mouse caging. The animal resource program was recently recertified by the Association for Assessment and Accreditation for Laboratory Animal Care (AAALAC).

Research Activities

Current NIH-funded grants support in vivo study of nitrite carcinogenesis, *in vivo* study of *Helicobacter hepaticus* and tumorigenesis, *in vivo* study of the pathogenesis of inflammatory bowel disease, in vivo study of *H. pylori* pathogenesis, *in vivo* study of gastric cancer, *in vivo* study of heat shock protein and *H. pylori* pathogenesis and *in vivo* study of micro-ecology of the gut and the pathogenesis of colitis. Total research funding for the fiscal year was $2.9 million.

FY2002 was the 14th year of the division's NIH postdoctoral training grant that has been funded through year 15. There are currently seven postdoctoral trainees, three of whom are enrolled in the graduate programs in the Division of Biological Engineering. Twenty-six trainees have completed our postdoctoral training program and 23 of them have now passed the board examination of the American College of Laboratory Animal Medicine. Nirah Shomer, while a postdoctoral trainee in DCM, received the Best Research Paper Award for 2001 from the Society for Experimental Biology and Medicine for a paper resulting from her research.

DCM faculty and staff published one book, eight chapters, 25 papers and 28 abstracts in FY2002 and presented numerous research papers at national and international meetings. Dr. Fox is the senior editor of the second edition of *Laboratory Animal Medicine*, which was published this past winter by Academic Press.

Academic Activities

Dr. James Fox has been appointed to the NIH Scientific Advisory Council of the National Center for Research Resources for 2002–2007. Dr. David Schauer was promoted to associate professor with tenure in the Division of Biological Engineering in 2001. Dr. Mary Patterson, a former postdoctoral trainee, was appointed clinical veterinarian in DCM for large animals on a half-time basis. Both she and Dr. Ihrig passed the board examinations of the American College of Laboratory Animal Medicine this past year. Additionally, Dr. Ihrig is the recipient of a NIH Mentored Clinical Scientist Development Award. She will be involved on a part-time basis as a clinician for DCM's transgenic core. DCM faculty and staff taught two graduate courses in the Division of Biological Engineering (BE 202 and 214).

Committee on Animal Care Activities

The web site for the Committee on Animal Care provides required forms, continuing education material and information on the CAC's activities. DCM staff in conjunction with the Committee on Animal Care has developed an online training program. Didactic training sessions for Institute personnel on topics pertaining to the care and use of laboratory animals are also offered. The

CAC has also developed an occupational health screen for animal related occupational health issues and periodically sponsors seminars on health issues such as zoonotic diseases. The CAC continued to distribute to other institutions in the United States and abroad two instructional videos, one focusing on the role and responsibilities of Institutional Committees for the Care and Use of Animals and the other focusing on the use of anesthesia in laboratory animals. Both are available to MIT researchers at the division or in the Schering-Plough Library.

James G. Fox;
Director
Professor of Toxicology

More information about the Division of Comparative Medicine can be found on the web at http://web.mit.edu/comp-med/.

Harvard-MIT Division of Health Sciences and Technology

The Harvard-MIT Division of Health Sciences and Technology (HST) brings engineering, science, technology, and medicine to the solution of problems in biology and human health. A successful collaboration that spans more than 30 years between the Massachusetts Institute of Technology (MIT), Harvard University, Harvard Medical School (HMS), area teaching hospitals and research centers, HST is a pioneer in interdisciplinary educational and research programs designed to educate outstanding minds, cultivate leaders, create knowledge, and generate cost-effective preventive, diagnostic, and therapeutic innovations. It is among the largest biomedical engineering and physician/scientist training programs in the United States.

Advances in biology and technology are bringing us to an era when diseases can be treated by "engineering" the phenotype of cells and tissues—when cell, tissue, and body functions can be manipulated using strategies that affect genes, cells, and their environment so they behave predictably. Advances in the diagnosis and prevention of disease are inexorably linked to these fundamental changes in our approach to disease management. Unquestionably, success in this area requires professionals with a broad range of skills that spans the domains of science, engineering, and medicine.

HST is dedicated to integrating these disciplines into an educational program that carries engineering and the physical and biological sciences from the laboratory bench to the patient's bedside, and, conversely, bring clinical insights from the bedside to the bench. HST's programs are committed to exploring the fundamental principles underlying disease, to seeking new pharmaceuticals and devices that ameliorate human suffering, and to training the next generation of physicians, scientists, and engineers to do the same. Thus, HST trains physicians with a deep understanding of the underlying quantitative and molecular science of medicine and biomedical research. HST PhD students similarly acquire a deep understanding of engineering and the physical and biological sciences. This unique training is complemented with hands-on experience in the clinic or in industry.

HST's administrative home is located at the Whitaker College of Health Sciences and Technology at MIT. As one of the five medical societies at Harvard Medical School, HST also maintains an office at the medical school's quadrangle campus in Boston. HST's two co-directors, Martha L. Gray for MIT and Joseph Bonventre for HMS, report to the provost and the vice president for research at MIT, as well as to the HMS executive dean for academic programs and the dean of HMS. Richard N. Mitchell, assistant professor of pathology at Harvard Medical School, serves as the division's associate director and director of student affairs.

Degree Programs

HST currently enrolls approximately 380 students who work with more than 200 faculty and affiliated faculty from the Harvard and MIT communities. Six multidisciplinary graduate degree options are offered, each targeted at students with different backgrounds and goals, each requiring a focused educational and research program, and each offering a different level of clinical training:

Medical Sciences Program (MD)

Medical Engineering and Medical Physics Program (MEMP)

Speech and Hearing Bioscience Technology Doctoral Program (SHBT)

Radiological Sciences Joint Program (RSJP)

Medical Informatics Program (MI)

Clinical Investigator Training Program (CITP)

Research Programs

HST's research programs reflect a mix of cultures in applying the tools of medicine, engineering, and science to problems in human health and medicine. Research initiatives are conducted in three targeted focus areas:

Biomedical Imaging

Informatics and Computational Biomedical Sciences

Regenerative Biomedical Technologies

and two crosscutting research programs:

Speech and Hearing Bioscience and Technology

Cardiovascular Sciences and Technology

Highlights

Events

Richard D. Klausner, executive director of the Global Health Program for the Bill and Melinda Gates Foundation, senior fellow of the National Academy of Sciences, liaison to the White House for counter-terrorism, and senior investigator at the National Cancer Institute, delivered the keynote address at HST's graduation on June 5, 2002. Of the 65 graduates who received degrees, 17 graduated with PhD degrees, 33 received the MD degree, and 15 received master's degrees. Eight MD students graduated *cum laude*. HST's graduating class of 2002 represented 19 states and 13 foreign countries.

The 2002 HST Forum "Beyond the Human Genome" surpassed the number of research posters submitted for previous years (75) and featured keynote speaker Eric S. Lander, professor of biology at MIT and director of the Whitehead Institute/MIT Center for Genome Research. The 15th annual HST Forum welcomed more than 200 attendees on March 14 at the Harvard Club of Boston.)

HST's annual John F. and Virginia B. Taplin Awards Symposium was held May 22 to a full audience, including the philanthropists for whom the awards are named. Presentations were given by the 2001 Taplin Fellows: Hugh M. Herr, Martha L. Bulyk, Fiona E. Murray, and Leonid A. Mirny.

The MGH/MIT/HMS Athinoula A. Martinos Center for Biomedical Imaging celebrated its first Research Day at MIT on September 13. "From Structure to Function and Beyond" included a poster session in the Building E25 atrium and provided students and faculty who conduct imaging research an opportunity to meet and interact.

The Martinos Center also dedicated two new state-of-the-art imaging systems at its Charlestown location on April 29. A 7-tesla magnetic resonance imaging system was made possible with the support of the Office of National Drug Control Policy, and a 306-channel magnetoencephalograph system was made possible with the support of the MIND Institute.

Maria S. Judge was appointed HST's new administrative officer and presented her photo exhibition "Toxic, Tattooed and Tougher than Margaret Thatcher: Chronicle of a Year with Cancer" to MIT. The 32nd showing of her exhibit was supported by MIT's Council for the Arts, the Kenneth Schwartz Center, and HST.

HST students, faculty, and staff volunteered to work on the front lines in the community: sixty-five students, staff, and faculty volunteered at the Greater Boston Food Bank on March 6, handling approximately 39,658 pounds of food for redistribution to shelters, soup kitchens, and other providers of meals to the hungry.

Since September, about a dozen HST students, alumni, and staff have spent one Saturday a month at the American Medical Resources Foundation in Brockton, checking and reconditioning medical equipment that will be donated to hospitals and clinics in developing countries.)

The HST Visiting Committee convened its biannual meeting in October at MIT and declared HST robust. The meeting provided an opportunity for HMS executive director of academic programs Dennis Kasper, MIT provost Robert Brown, and HMS dean Joseph Martin to demonstrate HST's leading role in transinstitutional education and research programs.

Academics

HST was awarded an NIH National Research Service Award Institutional Training Grant to provide predoctoral training in bioinformatics and functional genomics, thus establishing the new Bioinformatics and Integrative Genomics track (BIG) of the MEMP program. Its mission will be to train quantitative scientists in the biology, engineering, and information science of genomics. The BIG track seeks to train future researchers who must possess the necessary quantitative skills to manage and effectively use the huge amount of data generated by the Human Genome Project. BIG will address bioinformatics in a broad sense—encompassing the full range of work involved to extract functional dependencies from genomic data. Faculty members in the BIG curriculum include nationally recognized leaders from the basic biological sciences, engineering, computer science, genomics, bioinformatics, and epidemiology. Codirectors are Isaac S. Kohane, director of the Children's Hospital Informatics Program and associate professor of pediatrics at HMS, and Gregory Stephanopoulos, professor of chemical engineering at MIT. Both are HST affiliated faculty members.

The medical engineering track of the MIT master of engineering in biomedical engineering (MEBE) was announced. The MEBE program, launched in 2000 with a bioengineering track in the Division of Bioengineering, will be expanded in fall 2002 to include a medical engineering track offered by HST. Through this expanded program, HST and the Division of Bioengineering will prepare students for positions in the medical products, pharmaceutical, and biotechnology industries. The five-year program leads to a bachelor's degree in a science or engineering discipline and a master of engineering in biomedical engineering. The new medical engineering track, which will emphasize engineering applications in systems physiology and cellular, molecular and clinical medicine, will be offered under the auspices of HST beginning September 2002.

HST and MIT's Sloan School of Management jointly established the Biomedical Enterprise Program (BEP), a

unique double masters program dedicated to educating a new generation of leaders for tomorrow's biomedical enterprises. The mission of BEP is to equip its graduates to lead the commercialization of new technologies for the innovative diagnosis, prevention, and treatment of human disease in new and established companies. The program will offer a rigorous education in the fundamentals of entrepreneurial businesses, biomedical sciences, and technology. Frank R. Landsberger, co-founder and former chairman of Mojave Therapeutics and founding director of the Office of Science and Technology Development at the Mount Sinai School of Medicine, will serve as executive director of BEP. The curriculum committee was chaired by Fiona Murray, the Michael M. Koerner career development assistant professor of management of technology, innovation and entrepreneurship in the Sloan School.

The Speech and Hearing Sciences Program unveiled a new name: the Speech and Hearing Biosciences and Technology Program. The new name incorporates aspects of technology development that is now an integral part of the program.

New courses were added during AY2002 to enhance HST's curriculum.

HST 204: Industrial Experience in Medical Engineering and Medical Physics

HST 398: Introduction to Human Clinical Investigation

HST 508: Genomics and Computational Biology

HST 521: Biomaterials and Tissue Engineering in Medical Devices and Artificial Organs

HST 574: The Engineering of Intermediate Level Sensorimotor Control

HST 583: Functional Magnetic Resonance Imaging: Data

HST 918J: Economics of the Health Care Industries

HST 940J: Bioinformatics—Principles, Methods and Applications

HST 952: Computing for Biomedical Scientists

HST 970: Law, Innovation and Entrepreneurship in Health Care

A formal evaluation process for HST PhD courses was established.

The HST Curriculum Committee developed the *HST Credo of Professionalism*.

In addition to its first HMS DMD student in September 2001, HST admitted 30 MDs, 29 PhDs, three medical informatics master's candidates, and 11 clinical investigator training fellows. Student enrollment hit 385.

During the fall semester, HMS and HSDM launched online access to course materials in MyCourses. John D. Halamka (SM'98), assistant professor of medicine at HMS/BIDMC and associate dean of educational technology, was in charge of developing this system. HST MD student Griffin M. Weber is credited for major input into this password-protected system, which can be found at http://mycourses.med.harvard.edu/.

The MD Admissions Committee received 611 applications; a 17 percent increase over last year. One-quarter (154) of the applicants were interviewed, and 40 of those were offered admission. The gender numbers were equal. The PhD Admissions Committee received 141 applicants. Members of the committee interviewed 41 applicants, offering admission to 25 of them.

Faculty

New faculty appointments:

- Leonid A. Mirny was appointed assistant professor of health sciences and technology in HST. Previously, he was a junior fellow at the Harvard Society of Fellows, where his research involved biophysics and computational biology.
- New HST joint faculty member Martha L. Bulyk was appointed assistant professor of medicine at Harvard Medical School with an appointment in HST. Her research has focused on integrating functional genomics and bioinformatics.

New affiliated faculty members who joined HST in academic year 2001-2002: Lindsey R. Baden; Robert B. Banzett; Stephen C. Blacklow; George M. Church; David Cohen; Clark K. Colton; Randy L. Gollub; David N. Kennedy; Anne Klibanski; Jeffrey D. Macklis; Fiona E. Murray; William C. Quist; David A. Roth; Daniel K. Sodickson; Garrett B. Stanley; Ronald J. Steingard; Clifford J. Tabin; Rav Thadhani; William M. Well.

Faculty promotions:

- Kamran Badizadegan (MD'93), HST affiliated faculty—to assistant professor of pathology at Harvard Medical School/Children's Hospital-Boston
- Jonathan S. Bogan (MD'92), HST affiliated faculty—to assistant professor of medicine at HMS/MGH
- Aziz A. Boxwala, HST affiliated faculty—to assistant professor of radiology at HMS/BWH
- Emery N. Brown, HST faculty—to associate professor of anesthesia at Harvard Medical School/MGH
- Lucila Ohno-Machado, HST faculty—to associate professor of radiology at HMS/BWH
- Steven D. Rauch, HST affiliated faculty—to associate professor of otology and laryngology at Harvard Medical School/Massachusetts Eye & Ear Infirmary

- Daniel Z. Sands, HST affiliated faculty—to assistant professor of medicine at HMS/BIDMC

After teaching in HST for 29 years, Farish A. Jenkins, Jr., PhD, the Alexander Agassiz professor of zoology at Harvard University and professor of anatomy at HMS/HST, retired as head of HST 010: Functional Anatomy.

HST co-directors Martha L. Gray and Joseph V. Bonventre wrote the first of three commentaries in the May 2002 issue of *Nature Medicine*, addressing the recruitment, training, and retention of researchers skilled in translating scientific advances into "something with medical value." Their article, "Training PhD Researchers to Translate Science to Clinical Medicine: Closing the Gap from the Other Side," asserts the effectiveness of this model of training by describing the curriculum of HST's 24-year-old Medical Engineering/Medical Physics (MEMP) Program and its alumni. The authors emphasized the importance of MEMP's four months of clinical training to prepare PhDs for careers in medical research and presented supporting data on MEMP alumni.

MIT's Clinical Research Center, which is an academic component of HST, and the Massachusetts General Hospital's CRC completed an administrative merger. Each unit continues to operate more-or-less independently with its own director and staff. However, the activities of the two centers are being integrated and a single NIH grant—with a subcontract to MIT—will fund both centers.

Roger G. Mark, the distinguished professor of health sciences and technology in HST and professor of electrical engineering at MIT, and his wife Dorothy, were named housemasters of the new MIT graduate dormitory at Sidney and Pacific streets.

Milestones

Technical assistant Greg Dancer was one of two recipients of the first Steven Wade Neiterman award. This annual award is given to individuals who possess the following qualities: abilities in collaborative problem solving, in coaching colleagues, and in team building. Dancer was cited for his "motivation to create real solutions and his collaborative and diplomatic spirit."

Database manager/administrative assistant Jennifer Weiss won an MIT 2002 Infinite Mile award for her outstanding achievement, and was recognized for making extraordinary contributions in helping HST carry out its mission.

HST's e-newsletter *This Week in HST*, or *TWiHST*, grew to a weekly bulletin with dozens of notices on HST student and community life; information on lectures, workshops, and symposia on HST-related topics; notices of career-related programs at MIT and Harvard; and postings of fellowship and job opportunities. In addition to coverage of HST-specific information, *TWiHST* has made possible a wide dissemination of broader-based news to the HST community.

In its second year, HST's Irving M. London Society attracted 224 members and raised $184,608, which is a 300 percent increase from FY01 in unrestricted giving. The funds raised through the society provide valuable financial support for HST's students.

HST's Advisory Council convened on November 15 and March 14. The first meeting focused on communications bioscience and technology, and the second looked at the future of bioinformatics at HST.

HST faculty, staff, students, and alumni mourned the passing of:

- Neil S. Ghiso, 31 (MD'01), who died February 11 after a long battle with brain cancer. The Neil Samuel Ghiso Foundation (858 W. Armitage Ave., #111, Chicago, IL 60614) was established in his memory to foster compassionate care for chronically and terminally ill patients and their families through medical education and training.
- Huguette London, wife of founding HST director Irving M. London, who died April 11.
- MIT Professor Emeritus Felix M.H. Villars, a member of the HST faculty since its inception, who died of cancer on April 27.
- Walter A. Rosenblith, 88, MIT provost and Institute Professor emeritus, who died of complications from cancer on May 1. Rosenblith, who served as chair of the MIT Faculty 1967-69, associate provost 1969-71 and provost from 1971-80, was highly influential in the conception, planning and establishment of HST in the late 1960s and early 1970s.
- Lydia A. Cobb, assistant to founding HST director Irving M. London, who died of breast cancer on June 2.

Alumni/ae

Technology Review's June issue featured two HST alumni/ae in its list of 100 brilliant young innovators under 35. Stephen A. Boppart (MD'00-PhD'98), assistant professor of biomedical engineering at the University of Illinois at Urbana-Champaign, was noted for his work on optical-coherence tomography. Jennifer H. Elisseeff (MD'94-PhD'99), assistant professor in the Biomedical Engineering Department at The Johns Hopkins University, was cited for designing a liquid polymer that keeps cartilage cells alive.

Six regional chapter meetings of HST alumni were held across the country:

- Washington, DC/Baltimore: Eighteen alumni/ae from the Washington, DC/Baltimore area met for a reception and dinner on October 10 in Bethesda.
- Los Angeles: The first official HST alumni/ae meeting in southern California, held October 24, was attended by 18 graduates, nearly half of whom work in the Los Angeles area.

- San Diego: A gathering of six alumni/ae was held on October 25.
- Boston: Almost 30 alumni/ae from New England met for a reception and dinner at the University Park Hotel near MIT on November 25.
- New York City: Ten alumni/ae gathered at the Lotus Club in New York City on April 1.

A formal editorial board was appointed for *The Connector*, HST's alumni newsletter. It will meet twice annually to discuss guidelines and future directions.

Boston Magazine (February 2002) listed five HST alumni/ae among its 170 "Top Docs" in 23 fields:

- Lloyd Klickstein (MD'89) of Brigham & Women's Hospital for autoimmune diseases
- Ralph De la Torre (MD'92) of the Beth Israel Deaconess Medical Center for cardiac surgery
- Michael Fifer (MD'78) of Massachusetts General Hospital for cardiology
- Marc Semigran (MD'83) of Massachusetts General Hospital for cardiology
- Barbara Smith (MD'83) of Massachusetts General Hospital for oncological surgery

Student Honors and Awards

Lea M. Alhilali, second-year MD student, received the 2002 American Society for Artificial Internal Organs (ASAIO) Biomedical Engineering Student Fellowship Award.

Michael R. Folkert received MIT's William L. Stewart Jr. Award, which recognizes outstanding contributions by an individual student or student organization to extracurricular activities and events during the preceding year. Folkert was instrumental in establishing emergency medical training on the MIT campus.

Amy Lee, second-year MD student, received the 2002 HST Student Leadership Award, bestowed annually upon that student who contributes the most to the personal growth and professional development of his or her fellow students in HST.

Eric G. Sheu, first-year MD student, and incoming student Neelaksh K. Varshney were awarded Paul and Daisy Soros Fellowships for New Americans.

Shunmugavelu (Sham) D. Sokka won the Karl Taylor Compton Prize, the highest award presented by MIT to students in recognition of achievements in citizenship and devotion to the welfare of MIT. He was honored for his outstanding contributions to the MIT community as a whole, sustained over a significant number of years.

Howard Hughes Medical Institute award winners included six HST students: Christina L. Boulton, Kevin S. King, Shana E. McCormick, David T. Ting, Vladimir Vinarsky, Nikhil Wagle, and Hao Zhu. Three students received continuing support fellowships: Yvonne Ou, Stephanie N. Misono, and Harris Rose.

Faculty Honors and Awards

David Cohen, HST affiliated faculty and biomagnetism group leader at MIT's Francis Bitter Magnet Laboratory, was appointed associate professor of radiology at HMS and MGH. He is now a member of the Department of Radiology's Nuclear Magnetic Resonance Center for Biomedical Imaging at MGH.

Ernest G. Cravalho, HST founding faculty member and professor of mechanical engineering at MIT, received MIT's Everett Moore Baker Memorial Award for Excellence in Undergraduate Teaching.

Jeffrey S. Flier, HST affiliated faculty and the George C. Reisman professor of medicine at Harvard Medical School and Beth Israel Deaconess Medical Center, was elected to the American Academy of Arts and Sciences and appointed to the newly created position of clinical academic officer and Harvard faculty dean at BIDMC.

Byron J. Good, HST affiliated faculty and professor of medical anthropology in the HMS Department of Social Medicine, was appointed chair of the HMS Department of Social Medicine.

John J. Guinan, Jr., HST affiliated faculty and associate professor of otology and laryngology at Harvard Medical School and the Mass Eye and Ear Infirmary, was corecipient of HST's Irving M. London Teaching Award, which recognizes teaching faculty members who have made outstanding contributions to the training of HST's students.

Roger D. Kamm, HST affiliated faculty and professor of mechanical and bioengineering at MIT, was selected as one of the first eight Cambridge-MIT Fellows for 2001–2002.

Isaac S. Kohane, co-director of HST's track in bioinformatics and integrative genomics and associate professor of pediatrics at HMS and MGH, received the Clifford Barger Excellence in Mentoring Award from Harvard Medical School.

Robert S. Langer, Jr., HST faculty and the Kenneth J. Germeshausen professor of chemical and biomedical engineering at MIT, was awarded the 2002 Charles Stark Draper Prize by the National Academy of Engineering.

M. Charles Liberman, HST affiliated faculty member, director of the Eaton-Peabody Laboratory at the Massachusetts Eye and Ear Infirmary, and professor of otology and laryngology at Harvard Medical School, was

awarded HST's Thomas A. McMahon Mentoring Award, which is presented annually to the person who, through the warmth of his/her personality, inspires and nurtures HST students in their scientific and personal growth; and, through honest advice and generosity to all students and colleagues, sets an admirable example of excellence in mentoring.

Steven E. Locke, HST affiliated faculty and associate professor of psychiatry at HMS/BIDMC, was voted president-elect of the American Psychosomatic Society.

Joseph A. Majzoub, HST affiliated faculty and professor of pediatrics at Harvard Medical School and Children's Hospital-Boston, was corecipient of HST's Irving M. London Teaching Award, which recognizes teaching faculty members who have made outstanding contributions to the training of HST's students.

Valerie P. Pronio-Stelluto, HST affiliated faculty and instructor in medicine at HMS and Mt. Auburn Hospital, received the Leo A. Blacklow Teaching Award from Harvard Medical School.

Charles N. Serhan, HST affiliated faculty and professor of anesthesia at Harvard Medical School and Brigham and Women's Hospital, was appointed first distinguished scientist in anesthesiology, perioperative, and pain medicine at Brigham and Women's Hospital.

Myron Spector, HST affiliated faculty and professor of orthopedic surgery (biomaterials) at HMS, received the 2002 Clemson Award for Applied Biomaterials Research, from the Society for Biomaterials.

Jeffrey P. Sutton, HST affiliated faculty and associate professor of psychiatry at HMS/MGH, was appointed director of the National Space Biomedical Research Institute (NSBRI), a consortium of leading biomedical institutions, including HST. Sutton succeeds Laurence R. Young, HST affiliated faculty and the Apollo Program professor of astronautics at MIT, who was honored by the NSBRI for his leadership during its formative years.

Steven E. Weinberger, HST affiliated faculty and professor of medicine at HMS, received the Alpha Omega Alpha Robert J. Glaser Distinguished Teacher Award.

Augustus A. White, III, HST affiliated faculty and professor of orthopedic surgery at Harvard Medical School and Beth Israel Deaconess Medical Center, was appointed master of the Oliver Wendell Holmes Society at Harvard Medical School.

Warren H. Zapol, HST affiliated faculty and the Reginald Jenny professor of anesthesia at HMS, was elected to membership in the Institute of Medicine.

Educational Initiatives

VaNTH Engineering Research Center for Bioengineering Educational Technologies

A consortium of Vanderbilt University, Northwestern University, University of Texas at Austin, and HST, VaNTH is one of 20 Engineering Research Centers (ERC) funded by the National Science Foundation. The ERCs are charged with "providing an integrated environment for academe and industry to focus on next-generation advances in complex engineered systems important for the Nation's future." Unique among the ERCs, the VaNTH ERC focuses on the educational enterprise. Its mission: to "transform bioengineering education to produce adaptive experts by developing, implementing and assessing educational processes, materials and technologies that are readily accessible and widely disseminated. VaNTH will be a working model for how multidisciplinary, multi-institutional groups can define an approach to developing and testing curricula for rapidly evolving knowledge bases."

Faculty and researchers in the VaNTH ERC are developing challenged-based learning modules that teach bioengineering content and provide an opportunity for the learner to explore the inter-connections and relationships of the selected concepts. Using the learning sciences philosophy articulated in *How People Learn* (Bransford, Brown, and Cocking, 2000), each bioengineering module is constructed to be knowledge-centered, learner-centered, assessment-centered, and community-centered. All on equal footing, VaNTH focuses on four research thrusts: the bioengineering domain, learning sciences, learning technology, and evaluation and assessment. Through its educational thrust, VaNTH stresses involvement in research and educational outreach program.

BioMatrix

Founded in the spring semester of 2001 with support from the Alex and Brit d'Arbeloff Fund for Excellence in MIT Education, the BioMatrix mentoring program is designed to create a community of individuals interested in issues related to the life sciences and engineering. This includes undergraduate and graduate students, faculty, clinicians, researchers, and professionals in industry. BioMatrix was headed jointly this year by MIT professor and co-director of HST Martha L. Gray and by Dr. Richard N. Mitchell, associate director of HST at Harvard Medical School. The goal is for this community of like-minded individuals to contribute to the professional and personal growth of students during their MIT experience by providing an opportunity for students to connect with mentors who can help them explore and make career decisions.

This year's undergraduate membership was more than 100 students, many of whom became members in their freshman year and continued with the program into their sophomore year. Graduate students include PhD students

from several MIT departments as well as MD students in HST. Currently, approximately 50 graduate students are mentors to the undergraduates, and they receive mentoring from practitioner-mentors who include almost 50 basic and clinical researchers, academic physicians, clinicians, health economists and health policy faculty, and biologists in academia and industry. Monthly dinner events have been the backbone of the BioMatrix structure. Each is organized by a student-led subcommittee around a theme selected to appeal to the program's broad membership, but particularly to the undergraduates. This year, BioMatrix members also created one-on-one connections or small group interactions through self-selected activities called BIOs ("BioMatrix Interactions on the Outside"). These offerings, which can be either student- or mentor-initiated, included individual and small-group talks, visits, and professional and social opportunities for BioMatrix members.

A third part of the BioMatrix structure involves a web site where members can post profiles, including their academic and personal interests. Members can search profiles to find other members with similar interests. The web site also has an event calendar. The committee work of mentors and students on programming, membership, communications, and assessment has provided a way to engage members in the evolution of BioMatrix and is an excellent opportunity for relationship building. The committee structure gives student members an opportunity to enhance leadership skills. As the program matures, it is expected that additional senior undergraduate members will take on mentoring roles with newer members. BioMatrix provides all undergraduate members the opportunity to build close relationships with faculty and other professionals outside the academic context and to work with mentors in professional settings. As it grows, BioMatrix will seek to establish MIT's prominence in attracting students with career goals in the life science arena.

Research Achievements

The research of the HST core faculty and research staff covers a wide spectrum of biomedical areas. In addition to laboratories at HST, MIT, Harvard University, and the Harvard Medical School, research collaborations include several HMS teaching hospitals in the Boston area (including Massachusetts General Hospital, Brigham and Women's Hospital, Beth Israel Deaconess Medical Center, Dana Farber Cancer Institute, and Children's Hospital).

Regenerative Biomedical Technologies

The objective of HST's efforts in regenerative biomedical technologies is the cost-effective replacement of cell, tissue, and organ function. Toward this end, HST researchers apply the rigors of physical sciences to problems in medicine and biology. In particular, this work seeks to understand, harness, and engineer tissues, cells, and molecules. A principal site of this effort is the Harvard-MIT Biomedical Engineering Center, located on the MIT campus. There, seven resident faculty members supervise a scientific staff of 90. An additional 70 affiliated faculty at MIT and HMS use the center's extensive facilities and resources, which support work in a broad range of integrated sciences from molecular and cell biology to animal physiology.

Elazer R. Edelman (HST'83) is the Thomas D. and Virginia W. Cabot associate professor of HST and director of the Harvard-MIT Biomedical Engineering Center. Dr. Edelman and colleagues in his laboratory use elements of continuum mechanics, digital signal processing, molecular biology, and polymeric controlled release technology to examine the cellular and molecular mechanisms that transform stable coronary artery disease to unstable coronary syndromes. Tissue-generated cells, for example, deliver growth factors and growth inhibitors for the study and potential treatment of accelerated arterial disease following angioplasty and bypass surgery. The laboratory holds patents for drug delivery devices, tissue engineered implants, and new drug formulations.

Michael S. Feld heads the MIT Laser Biomedical Research Center, an NIH Biotechnology Resource Center housed in the MIT Spectroscopy Laboratory, which develops basic scientific understanding, new techniques, and technology for advanced biomedical applications of lasers. Fluorescence, reflectance, near-IR Raman, light-scattering spectroscopy, and low coherence interferometry are being used for histological and biochemical analysis of tissues, diagnosis and imaging of disease, and cell biology applications. Clinical studies are conducted with researchers from the Cleveland Clinic Foundation, Medical University of South Carolina, Brigham and Women's Hospital, Metrowest Hospital, Beth Israel Hospital and New England Medical Center. Clinical studies using trimodal spectroscopy, the combined application of intrinsic fluorescence, diffuse reflectance, and light scattering spectroscopies, have demonstrated successful diagnosis of dysplasia in Barrett's esophagus, the urinary bladder, adenomatous polyps, the oral cavity and the uterine cervix. Light scattering spectroscopy was used to measure and image subcellular structures much smaller than an optical wavelength. Novel low coherence interferometry techniques, which use two harmonically related wavelengths to measure optical phase, have been developed. Exceedingly small refractive index and length changes, tomographically mapped, were used to study structure and dynamics of cellular organelles. Raman spectroscopy was used to measure blood analytes with clinical accuracy and identify morphology of breast lesions. The experimental and theoretical work of this program is advancing new laser diagnostic technologies in the fields of medicine and cell biology.

Hugh M. Herr and colleagues at MIT's Leg Laboratory seek to understand how the mechanics, energetics, and

control of locomotion are determined by speed, animal size, and fundamental forces such as gravity and inertia. Towards this goal, they are testing hypotheses that integrate the mechanics, energetics, and control of locomotion, and have developed morphologically realistic, physics-based computer models that predict important features of mammalian trotting and galloping. Their virtual models span nearly three orders of magnitude in body size: two horses, a goat, two dogs, and a chipmunk. Using these virtual creatures, they are testing the effects of systematic changes in structure and control parameters. In another project, an auto-adaptive knee prosthesis is being developed for trans-femoral amputees that will move naturally at all locomotory speeds and perform equally well for all amputees. Using state of the art prosthetic knee technology, a prosthetist must pre-program knee damping values until a knee is comfortable and safe to use. Their knee prosthesis automatically adapts to the amputee without pre-programmed information of any kind from either amputee or prosthetist. The adaptation scheme successfully controls early stance resistance, swing phase peak flexion angle and extension damping, suggesting that local sensing and computation are all that is required for an amputee to walk in a safe, comfortable and smooth manner. Finally, in work with the Biomechatronics Group, Dr. Herr is developing small robots actuated by animal derived muscle tissue. In this investigation, muscle tissues are specifically engineered for machine actuation. Genetic, chemical, electromechanical, and temperature interventions are used to enhance muscle robustness and contractile function *in vitro*. Two types of muscle tissue are being examined: native and cultured tissues from genetically modified mice and native whole muscle from non-mammalian sources such as marine invertebrates. Once engineered, the contractility and robustness of these tissues will be characterized and comparisons will be made to current artificial muscle technologies.

Robert S. Langer, Jr., a pioneer in biomedical and chemical engineering, is studying new ways to deliver drugs, including a new microchip that can deliver drugs in a pulsable fashion. He is also researching tissue engineering and has created new approaches for creating blood vessels, cartilage, and many other tissues. He has also developed biomaterials for medicine, including plastic that slowly dissolves and releases therapeutic drugs directly to tumors. In 1996, this led to the first new treatment for brain cancer approved by the FDA in more than twenty years.

Roger G. Mark, distinguished professor of health sciences and technology, together with colleagues at Beth Israel-Deaconess Medical Center, Boston University, and McGill University, continue to develop the new NIH-funded "Research Resource for Complex Physiologic Signals." The resource investigates cutting-edge physiologic signal processing techniques, and freely distributes extensive archives of annotated physiologic data and signal processing software to the international research community via the Internet (http://www.physionet.org/). Dr. Mark's group also is developing computational cardiovascular models to better understand orthostatic intolerance induced by space flight and is exploring innovative approaches to "intelligent" patient monitoring.

Frederick J. Schoen has made major investigative contributions to understanding the problems of currently available prosthetic devices and patient-management strategies. He has identified, elucidated the mechanisms of, and solved several of the critical problems associated with the biomaterials and devices used clinically, especially substitute heart valves. His approaches have used basic biology, evaluations of clinical implants that have failed, and industrial development studies of new and modified configurations and biomaterials. Ongoing investigations are focusing on cell-extracellular matrix interactions in the mechanisms of native heart valve degeneration and as determinants of the structure-function-quality correlations in heart valves fabricated by tissue engineering methods.

Martin L. Yarmush and colleagues are contributing to several fields, including tissue engineering, gene therapy and nucleic acid biotechnology, genomic and proteomic technology, and metabolic engineering. Drs. Yarmush, Mehmet Toner, and Ronald G. Tompkins are collaborating on one of the world's leading programs to establish a liver support device using hepatocytes and microfabrication techniques. In addition, in the area of tissue engineering, Drs. Jeffrey R. Morgan and Yarmush are developing the next generation of skin substitutes using genetically modified cells. In the areas of gene therapy and nucleic acid biotechnology, Dr. Yarmush's laboratory, together with those of Drs. Morgan and Arul Jayaraman, are investigating rate limiting aspects of gene therapy and antisense therapy. Drs. Yarmush, Toner, Morgan, and Jayaraman are also collaborating on a new platform for monitoring real time gene expression using a living cell microarray, which can provide minute by minute information in a massively parallel format. Finally, Drs. Yarmush and François Berthiaume are using the tools of metabolic engineering to investigate the complex metabolic changes that occur in chronic disease and major injury.

James C. Weaver, HST senior research scientist, and his research group, have extended their development of a new computer simulation method to image-based modes at the cellular level, such that realistic models of human skin stratum corneum and other tissues can be created and solved for "in silico" assessment transport of beneficial and hazardous chemicals.

Lisa E. Freed, HST principal research scientist, supervises a research team working on tissue engineering. Her research interests include cell and developmental biology, biomaterials, and biomedical engineering, and in particular the integrated use of cells, three-dimensional scaffolds,

and bioreactors to engineer functional skeletal and cardiovascular tissues. The goals are to improve basic understanding of tissue development through controlled in vitro studies and to generate clinically useful tissue equivalents. She also participated in teaching Biomaterials and Tissue Engineering in Medical Devices and Artificial Organs (HST 521).

Gordana Vunjak-Novakovic, HST principal research scientist, is supervising research teams working on tissue engineering of skeletal and cardiac tissues, and biological research in space. Her research interests include tissue engineering, bioreactors, and transport phenomena in living systems, and in particular the integrated use of cells, biomaterials and bioreactors in quantitative studies of cell function and tissue development. She is serving as the science lead of the design and testing of the cell culture system for the International Space Station. Her teaching responsibilities include Biomaterials and Tissue Engineering for Medical Devices (HST 588, course codirector), Quantitative Physiology of Cells and Tissues (6.021J, recitation instructor), and Biomaterials and Tissue Engineering (ChE 164 at Tufts University, lecturer).

An important scientific challenge in regenerative biomedical technologies research is to understand biological complexity: how life and cellular function emerge from the interactions of these different components. HST's work in this area aims to develop entirely new analytical tools and computational models needed to describe the nonlinear emergent behavior of complex biological systems.

Joseph V. Bonventre (HST'76), HST codirector, studies the mechanisms of cellular and tissue injury and repair, particularly as related to ischemic injury to the kidney. Recent studies have focused on the role of inflammation and adhesion in the pathophysiology of acute renal failure. A novel adhesion molecule, KIM-1, has been cloned that is expressed at very high levels during the recovery phase of acute renal failure and in models of chronic renal disease as well as in a number of human kidney diseases including polycystic kidney disease. This molecule is shed from the cell membrane, and it appears in the urine of patients with kidney injury at an early stage of the disease process. Using PCR-based subtraction techniques and bioinformatics, many additional genes whose regulation is altered during repair have been identified. Many of these represent potential targets for therapeutic interventions to prevent or treat kidney injury. Bone marrow derived stem cells have differentiated to epithelial cells replacing injured kidney cells. Approaches are being explored to facilitate this process and potentially regenerate the tubular epithelium and restore function to a failing kidney. Transcription factors are important determinants of the cellular repair processes after an ischemic insult to the kidney. A novel kidney-specific zinc finger transcriptional repressor, Kid-1, whose expression is regulated in renal ontogeny and by ischemia/reperfusion was cloned and characterized. The Kruppel Associated Box-A (KRAB-A) motif of this and other zinc finger proteins was identified as a common repressor motif. A transcriptional repressor, KRIP-1, that interacts with KRAB-A has been cloned. A new family of proteins that associates with KRIP-1 (Trip-Br family) have been characterized which interact with E2F/DP1, two critical proteins for cell cycle regulation. A second major focus of the lab is phospholipase A2 (PLA2) and the role of this family of enzymes on acute tissue injury, apoptosis, signal transduction and nuclear events including transcription. Using the yeast two-hybrid system, a nuclear protein that interacts with the cytosolic 85 kDa cPLA2 has been identified. A cPLA2 knock-out mouse has been created to study the function of PLA2s in signal transduction and renal, respiratory, gastrointestinal and neurological disease. Gene therapy approaches with adenovirus are being used.

George Q. Daley (HST'91) is investigating the signaling pathways that allow the BCR/ABL oncoprotein to induce leukemia. His laboratory has demonstrated that a novel class of pharmaceutical agents called farnesyl transferase inhibitors have potent activity against BCR/ABL-induced leukemia and active clinical testing of these agents are underway. His lab has also demonstrated that hematopoietic stem cells develop from pluripotent embryonic stem (ES) cells that are differentiated in culture, and is the first to combine nuclear transfer cloning and ES cell differentiation (therapeutic cloning) to treat a genetic disease in the mouse, an important step towards using ES cells for cellular therapies.

Lee Gehrke, professor of health sciences and technology, studies the replication and assembly of viruses that use RNA as their genetic material. Important biochemical processes that allow viruses to replicate depend on docking interactions between RNA and protein molecules. Dr. Gehrke's laboratory is focused on identifying these docking signals, an effort that will facilitate therapeutic approaches for blocking virus replication and assembly. The research has led to the molecular identification of amino acids and nucleotide sequences that are crucial for forming the RNA-protein interactions; moreover, the work also suggests the shape or conformation of the molecules changes upon binding. Another aspect of his work is learning how viruses are able to gain an advantage over the infected host cell in expressing their own genetic information. Nucleotide signals in a viral messenger RNA have been identified that give the virus a competitive advantage, and the lab is now working to elucidate the detailed mechanism.

Richard N. Mitchell, HST's associate director, researches the mechanisms underlying acute and chronic rejection in solid organ allografts, with specific emphasis on heart transplants. His work runs the gamut from mouse transplant models to human clinical transplantation, and is focused on understanding the specific immunologic

pathways that drive rejection and ultimately graft failure. His lab is particularly interested in the mechanisms that induce the process of "chronic rejection" whereby the vessels in transplanted hearts become progressively more occluded until the grafts get starved for blood and die. The research may have much broader applicability, since the inflammatory mediators that drive the occlusive process in transplanted hearts may also be involved in mediating the vascular wall thickening that characterizes more "typical" atherosclerosis. Dr. Mitchell's laboratory uses several genetically engineered mice (so-called "knock-out" mice), which are either deficient in cell surface molecules that promote the cellular cross talk necessary to promote rejection, or which lack particular "cytokine" mediators or their receptors. In collaboration with other members of the HST community, such as Drs. Elazer Edelman and Andrew Lichtman, Dr. Mitchell has been evaluating new interventions to prevent the chronic vascular pathology. His group has also developed collaborations with several pharmaceutical firms such as Schering-Plough, Bristol Myers-Squibb, and Novartis.

Jane-Jane Chen, principal research scientist in HST, studies the regulation of hemoglobin synthesis and erythropoiesis by the heme-regulated eIF-2 alpha kinase (HRI). Her group has knocked out the HRI gene in mice, and established that HRI, which is expressed predominantly in erythroid cells, regulates the synthesis of both a and b globins in red blood cell precursors by inhibiting the general translation initiation factor eIF2. This inhibition occurs not only when the intracellular concentration of heme declines, but also occurs when cells are under various cytoplasmic stresses. HRI is responsible for the adaptation to well tolerated microcytic, hypochromic anemia occurred in iron deficiency. Our recent studies of mice with compounded HRI and b-globin or ferrochelatase deficiencies demonstrate that HRI can be a modifier gene and affect the severities of b-thalassemia and erythropoietic protoporphyria in mice. These data have significance for further understanding the physiological role of HRI as a guardian of hemoglobin synthesis and red blood cell production against various stresses.

HST's research in regenerative biomedical technologies also encompasses investigations into therapeutics and clinical human studies, which provide important insight into disease mechanisms and new diagnostic procedures. The opportunities available through MIT's Clinical Research Center, the Harvard Medical School teaching hospitals, and HST's Clinical Investigator Training Program significantly enhance the division's research and educational initiatives and further enable translational efforts from bench to bedside.

Robert H. Rubin, the Gordon and Marjorie Osborne professor of HST, has spent much of his clinical career studying and caring for transplant patients. Among his accomplishments are the development of new strategies for preventing the most important infections, particularly those due to viruses and fungi; the establishment of the link between certain viral infections and allograft injury and the development of certain malignancies; and the development of novel antimicrobial approaches that are effective not only in transplant patients, but also in such other immunocompromised patient populations as those with AIDS and cancer. In 1999, he was named to the chairmanship of the Infectious Disease Section of the International Transplantation Society and assumed the position of editor in chief of the journal, Transplant Infectious Disease. More recently, he has taken on the responsibility of developing Internet-based educational programs for international use and in 2002 worked as editor-in-chief for *Good Clinical Practices in Clinical Research* and *Fungal Infections: Grand Rounds.* As director of HST's Center for Experimental Pharmacology and Therapeutics, Dr. Rubin has pioneered the application of positron emission tomography, magnetic resonance imaging and spectroscopy, and other measurement technologies to the development of new drugs, including those designed for the transplant patient. In addition to his other responsibilities, Dr. Rubin is associate director of the Division of Infectious Diseases at the Brigham and Women's Hospital, charged with the responsibility of directing the clinical service and the clinical research program.

Drs. Rubin and Alan C. Moses head the two year Clinical Investigator Training Program, a joint effort of the Beth Israel-Deaconess Hospital, HST, and Pfizer, Inc. Trainees gain direct experience in clinical investigation and a strong foundation in the statistical and computational sciences, biomedical ethics, principles of clinical pharmacology, in vitro and in vivo measurement techniques, and aspects of the drug development process. After fulfillment of thesis requirements and successful performance on a qualifying exam, graduating trainees receive a MMSc degree in clinical investigation from HST.

Richard J. Wurtman, program director of MIT's Clinical Research Center, also conducts research into Alzheimer's disease. A generally held—if unproved—view of Alzheimer's is that dementia results from toxic effects of an abnormal protein, called amyloid, which is a polymer of small fragment (A-beta) of a protein (APP) produced normally in all cells. Hence, a major goal of researchers working to treat this disease is to find drugs that will decrease the formation of A-beta from APP and increase the production of APPs other major metabolite APPs ("soluble APP"). Dr. Wurtman's laboratory has shown that both the synthesis of the APP and the proportions of it that are broken down to A-beta or soluble APP are under the control of the particular neurotransmitters and "second messengers" they generate. Thus, by using drugs that act on these receptors, it should be possible to block the formation of APP and all its metabolites, or promote the formation of soluble APP and suppress A-beta. This has

been demonstrated in tissue culture and is in the process of being demonstrated in animal models of Alzheimer's. The next step, probably involving industry collaboration, involves devising a treatment to decrease the amount of amyloid in the Alzheimer's disease brain. This treatment may conceivably ameliorate the dementia of the disease.

Biomedical Imaging

Biomedical imaging is a relatively young field that enables physicians and scientists to "see" and better understand tissue and organ function. It provides investigators with the ability to visualize the structure of tissues and to capture their function on film. One type of biomedical imaging is magnetic resonance imaging (MRI), also known as nuclear magnetic resonance (NMR). Using electromagnetic fields and radio waves to read minute shifts in the magnetic alignment of protons in soft tissue such as the brain, it involves the collaboration of engineers, computer scientists, neuroscientists, and physicians. An important advance called functional MRI (fMRI) shows how living tissues are functioning in real time. For example, fMRI can make a 100-millisecond scan every few seconds to detect variations in regional blood flow within the brain to signal sight, hearing, thinking, or feeling. Combining many fMRI scans makes a real time "movie" of functioning organs, a technique that has been especially useful in cognitive neuroscience and psychology.

Emery N. Brown devotes his research to statistical modeling of problems in neuroscience. Working jointly with colleagues in MIT's Brain and Cognitive Sciences Department, he is developing statistical signal processing techniques to analyze how neural systems encode information about relevant biological stimuli in their ensemble firing patterns. The techniques involve signal processing methods based on point process filtering, and have been successfully applied to the study of how ensembles of pyramidal cells in the rat hippocampus encode the animal's representation of its spatial environment. In collaboration with members of the MGH NMR Center, Dr. Brown is developing statistical methods to characterize the dynamic properties of functional magnetic resonance imaging (fMRI) signals. A forthcoming application of these methods will be to study anesthesia induced loss of consciousness monitored with fMRI. In collaboration with colleagues at the Brigham and Women's Hospital, Dr. Brown has developed statistical models to measure precisely the period of the human biological clock and to characterize the properties of circadian and neuroendocrine rhythms.

Martha L. Gray (HST'86), HST co-director, and collaborator Deborah Burstein (HST'86) use magnetic resonance to measure the composition and functional integrity of cartilage. Over the last century, little progress has been made in developing effective preventative and therapeutic strategies for arthritis, other than total joint replacement. Among the challenges limiting progress has been the fact that there were no nondestructive means to visualize cartilage. Pioneering work by this team has yielded a clinically feasible method that is now employed in pilot studies. Work with Genzyme's Carticel™ product revealed an apparent improvement by 18 months after surgery. An evaluation of dysplastic hips revealed composition correlates with pain. These are examples of information that were previously unavailable. Clinicians and researchers have had to struggle to understand and treat diseases they could not see until significant cartilage destruction had occurred. This situation has the potential to improve dramatically with the method Drs. Gray and Burstein have pioneered. In the past year, this method has been used to demonstrate nondestructively biochemical alterations in intact human cartilage. In addition, pilot clinical studies have begun to demonstrate subtle alterations in cartilage, which may be amenable to early pharmacologic intervention

Bruce R. Rosen (HST '84) is director of the Nuclear Magnetic Resonance Center at the Massachusetts General Hospital and the MGH/MIT/HMS Athinoula A. Martinos Center for Biomedical Imaging. The Martinos Center fosters biomedical imaging research that spans scientific disciplines from basic research to clinical investigation and develops medical applications for these new technologies. This new biomedical imaging center is a partnership between HST, Massachusetts General Hospital, and the Harvard Medical School. Its mission is to build the next generation of functional imaging tools; to apply these tools to biologically, neurologically, and clinically relevant problems; to train physical, biological, and clinical scientists; and to provide a hub for interdisciplinary collaborations between Harvard, MIT, and other institutions worldwide. Dr. Rosen is well known for his contributions in the area of "functional" imaging—that is, magnetic resonance images of the brain in which areas having some functional activity (e.g., visual cortex) are highlighted by receiving increased blood flow. The techniques he and his colleagues have developed are being used by hospitals throughout the world to evaluate patients with stroke, brain tumors, dementia, and other mental illness. Recent work has focused on the fusion of functional MRI data with information from other modalities, including very high temporal resolution signals using magnetoencephalography (MEG) and noninvasive optical imaging.

Informatics and Computational Biomedical Sciences

Knowledge discovery and its dissemination in health care have been deeply influenced by recent advances in computer science and engineering. Medical and biological informatics is the use of computer technology to extract, transport, and manage information from

medical and biological data, and to model and support human decision making in clinical and biological domains. Research challenges include: deducing and mapping genomic structure, predicting structure and function of proteins, representing medical knowledge for modeling diagnostic and prognostic decision making processes, extracting new information from large clinical and biological data sets, building comprehensive electronic medical records (EMR) and clinical information systems, interfacing monitoring devices and the EMR, assuring privacy and confidentiality in medical transactions, analyzing and manipulating images, recognizing patterns of disease progression, analyzing costs and benefits related to medical use of information technology, computer aided instruction, and utilizing the Internet for providing education and health care services.

Martha L. Bulyk uses computational and experimental approaches to study transcriptional regulatory networks in model organisms and in the human genome. She and her colleagues use various computational methods to identify likely DNA regulatory elements in the human genome. They are also applying and developing new microarray technologies for the high-throughput characterization of the binding specificities and regulatory roles of transcription factors (TFs). Predicted regulatory elements and corresponding TFs will be verified using these technologies. These studies will permit a better understanding of the locations and organization of regulatory DNA elements in higher eukaryotic genomes, and will aid in understanding the regulatory complexity resulting from combinatorial interactions of TFs. These data will also permit the development of more accurate algorithms to predict DNA regulatory elements in the human genome. Furthermore, the combination of these data with mRNA expression analysis, protein interaction databases and prior genetic and biochemical data in the literature will allow the construction of more detailed connectivity maps of transcriptional regulatory networks. Dr. Bulyk's laboratory will make its data publicly available, enabling other researchers to focus their efforts on those genomic regions most likely to contain regulatory elements.

Robert A. Greenes, director of HST's Biomedical Informatics Training Program, established the Decision Systems Group (DSG) at Brigham and Women's Hospital in 1978 to pursue the application of information technology in health care education and decision making. Dr. Greenes has a 38 year history of work in the area of biomedical informatics. The DSG lab, which includes physicians, computer scientists, database experts, and specialists in graphics and educational technology, has a major focus on developing means to enhance decision support and education and integrate these capabilities into clinical practice. Primary technologies involve knowledge representation, machine learning, decision science, and information retrieval. The DSG is also working in the area of bioinformatics, particularly in the development and application of machine learning, classification, and prediction methods for the analysis of DNA microarray data and of flow cytometry data characterizing cellular proteins. The HST-based Biomedical Informatics Training Program, which Dr. Greenes directs, is funded by an institutional training grant from the National Library of Medicine. This year, the program received a competitive renewal award with an annual budget of approximately $2 million.

Isaac S. Kohane, director of HST's bioinformatics and integrative genomics track, is involved in leading multiple collaborators in bioinformatics and the functional genomics of tumorigenesis, neurodevelopment, neuroendocrinology, and transplantation biology. He also leads several national efforts in distributed clinical computing, biosurveillance, and decision support with an emphasis on the use of cryptographic methods to protect patient privacy.

Leonid A. Mirny, assistant professor of health sciences and technology, conducts research in computational structural and system biology. His efforts in computational structural biology are focused on development of novel computational tools to analyze and predict structures of proteins, their complexes and protein-DNA interactions. His system biology projects integrate large scale analysis of proteomic and genomic data with molecular simulations of proteins. He is interested in developing stochastic computational models of genetic and biochemical networks, cellular regulation and signal transduction. His research is aimed at efficient extraction of biological knowledge from experimental genomic and proteomic data as well as at fundamental understanding of molecular mechanisms involved in cellular regulation.

Lucila Ohno-Machado investigates machine-learning techniques to extract information from databases, especially in the form of predictive models for prognosis. She has used special methods to predict survival for patients with certain conditions, to assess the risk of myocardial infarction in certain populations, to predict ambulation for patients with specific kinds of spinal cord injuries, and to predict outcomes for invasive interventions. Her research is focused on the development and evaluation of models involving binary outcomes using mixtures of machine learning and statistical models. These models can be based on clinical and genomic data. She is interested in deploying practical models for direct use by patients, physicians, and health care managers, so that they can make decisions that are more informed. An example in this area is a project that uses artificial intelligence techniques for dealing with uncertainty to select suitable clinical trials for patients with certain types of breast cancer. Other areas of interest include decision support to help patients recognize early symptoms of a heart attack, remote monitoring, and other uses of information technology to facilitate collection and analysis of biomedical data.

Speech and Hearing Bioscience and Technology

In a world with increasingly complex societal interaction, there is an imperative need to understand how humans communicate, and what can be done to assist those with impaired abilities to produce speech or to perceive auditory signals. HST's Speech and Hearing Sciences research focuses on the biological and physical mechanisms underlying human communication by spoken language. The processes addressed by these sciences include the physical acoustics of sound and the perceptual and neurophysiological bases of hearing, as well as the cognitive and linguistic levels of processing by talkers and listeners. This research, and its application to human needs, is inherently an interdisciplinary activity.

Understanding the process of receiving and translating speech sounds has been the focus of several HST researchers, including Dennis M. Freeman. Via a bundle of microscopic hairs, sensory cells in the inner-ear sense sound-induced motions of inner-ear structures, which trigger neural messages that relay information about sound to the brain. Dr. Freeman and his colleagues have measured the motions of a lizard's inner-ear sensory cells in response to sound stimulation. They have also measured mechanical properties of the tectorial membrane, an essential tissue that mechanically stimulates hair cells. In this work, they have obtained the first quantitative measurements of the bulk modulus, fixed charge concentration, and point impedance of the tectorial membrane. In their related microelectromechanical systems (MEMS) work, his group developed a Mirau interferometric imaging system to characterize MEMS motions and used it to measure dynamic profiles of flexible MEMS (optical gratings). This dynamic profilometer for MEMS is likely to have important applications in many MEMS labs. In the area of synthetic aperture optics, in addition to building a 50-beam synthetic aperture light projector using 488 nm light, his group also built a surface-acoustic-wave (SAW) light modulator and used it to break a single incident beam at 193 nm into hundreds of output beams with controlled amplitudes and phases. The SAW optical modulator is likely to have wide application as a general light modulator.

M. Charles Liberman, director of the Eaton-Peabody Laboratory at the Massachusetts Eye and Ear Infirmary, studies the neurobiology of hearing and hearing loss in animals and humans. His work on normal hearing investigates the structure and function of the four major classes of afferent and efferent neurons connecting the inner ear with the brain. Notable recent progress includes the discoveries that sound-evoked activation of one of the efferent feedback pathways protects the inner ear from permanent acoustic injury and that inter-subject variation in the strength of this feedback reflex can predict susceptibility to hearing damage in noisy environments. His work on hearing loss is currently focusing on prevention of presbycusis, or age-related hearing loss. His laboratory has recently demonstrated a genetic manipulation in mice, which dramatically minimizes age-related hearing loss as well as the age-related loss of sensory cells. The molecular mechanisms underlying this protective effect are now under investigation.

John J. Rosowski is codirector of the Wallace Middle-Ear Research Unit of the Eaton-Peabody Laboratory at the Massachusetts Eye and Ear Infirmary. He and his colleagues strive to understand how the structures of the external and middle ear affect what we hear by measuring the function and structure in normal and pathological ears. On the order of one percent of the human population suffers from some form of chronic middle-ear disease, and thousands of surgeries are performed annually at the Massachusetts Eye and Ear Infirmary alone to control these diseases and restore hearing. The Wallace unit is investigating the clinical utility of laser-Doppler measurements of sound-induced middle-ear velocity in patients and human subjects in order to diagnose middle-ear disease and evaluate post-surgical results. Preliminary results indicate certain hard to diagnose ossicular abnormalities can be differentiated by vibrometry, and that the reasons for a large percentage of middle-ear surgical failures can be determined by this procedure.

Bertrand Delgutte and his colleagues seek to understand the neural mechanisms for perception of sounds. A focus of their research in the past year has been to improve processors for cochlear implants, prosthetic devices that electrically stimulate the auditory nerve in order to restore hearing in the profoundly deaf. Most current processors only deliver information about the slowly varying temporal envelope of sounds, and discard the rapidly varying, fine time structure. To assess the relative perceptual importance of these two components of sounds, HST graduate student Zachary Smith, psychophysicist Dr. Andrew Oxenham and Dr. Delgutte created novel chimeric sounds combining the temporal envelope of one sound with the fine structure of another. They found that speech reception depends primarily on the envelope, while melody recognition and sound localization depend on the fine structure. This finding suggests that modifying cochlear implant processors to deliver fine structure information would improve music appreciation and, for patients implanted in both ears, speech reception in noise. In related work with HST graduate student Leonid Litvak and Dr. Donald Eddington, he showed that a new strategy for delivering fine structure information in cochlear implants gives a more natural representation of sounds in the auditory nerve than do existing processors. The effectiveness of this strategy is now being tested in human patients.

Cardiovascular Science and Technology

HST's cardiovascular research is dedicated to developing innovative diagnostic and therapeutic technologies and medications that will have an impact on clinical care within

a ten-year period. Traditionally, academic institutions have focused on long-term basic research, whereas the research efforts of pharmaceutical companies, as well device and equipment manufacturers, have focused on development. HST's cardiovascular investigations focus on novel ideas that bridge this gap between basic research and applied development. In order to achieve translational research and to train new investigators in this field, HST builds on its strong ties to academic and clinical laboratories, including the Boston Heart Foundation, and develops new ties with industry. In cooperation with these partners, HST's cardiopulmonary effort will be able to provide products designed for a patient's specific phenotype when developing new technologies and drugs.

The laboratory of Richard J. Cohen (HST'76), Whitaker professor of biomedical engineering, is involved in the development of cardiovascular diagnostic and therapeutic technologies. One of the technologies developed in his laboratory is the noninvasive measurement of microvolt level fluctuations in electrocardiographic signals to identify individuals at risk for sudden cardiac death from heart rhythm disturbances. This technology, called the measurement of microvolt T-wave alternans, has been commercialized by a company that Dr. Cohen helped found—Cambridge Heart, Inc. The technology has been successfully tested in a wide range of international clinical trials and is currently being introduced into widespread clinical practice. Under sponsorship of the National Space Biomedical Research Institute, Dr. Cohen is using this technology to determine whether long-duration space flight increases the risk of life-threatening heart rhythm disturbances. Dr. Cohen's laboratory was also involved in demonstrating the effectiveness of a new pharmacologic countermeasure to another adverse effect of space flight on the cardiovascular system. After long-duration space flight, astronauts develop orthostatic hypotension, meaning that their blood pressure drops when they attempt to sit or stand. This effect may be so severe as to cause syncope or fainting. Dr. Cohen's laboratory collaborated in studies demonstrating that a single oral dose of the sympathetic alpha-agonist midodrine taken at the end of simulated space flight is effective in markedly reducing the development of orthostatic hypotension. Studies to test this drug in astronauts are in progress.

Robert S. Lees, professor of health sciences and technology, in collaboration with Roger Kamm, professor of mechanical engineering, and Raymond Chan, former medical engineering graduate student and currently instructor in radiology at Massachusetts General Hospital and Harvard Medical School, have developed a noninvasive method for estimating carotid arterial motion and strain from real-time ultrasound image sequences. The blood pressure variation in the carotid artery with each heartbeat causes cyclic changes in its wall, which relate directly to the amount of arteriosclerosis in the vessel. Early changes in these arteries, which supply blood to the brain, can therefore be monitored with this novel method to improve diagnosis of early carotid atherosclerosis and ultimately aid in the prevention of stroke prevention.

Daniel C. Shannon is a founder of the field of pediatric intensive care and pulmonology. For more than two decades, he has been furthering his breakthrough studies into the rare condition of congenital central hypoventilation syndrome (CCHS). Dr. Shannon and his colleagues have added incrementally to their framework of knowledge about the problem, using whatever new tool they could find to test specific hypotheses. One of his associates in these studies recently received an award from the NIH for discovering the first gene that controls respiration. Still, the clinical problems—like a child's failure to breathe adequately when asleep—continue to stump clinicians and researchers alike. His latest research reflects the use of technology to serve patients better.

Future Plans

—Promote the Athinoula A. Martinos Center as the leading imaging and research center in the country. Plans are underway for Brainstorm 2002, a neuroimaging conference in Athens, Greece, in September 2002. This will involve neuroscientists from the Martinos Center and other top neuroscientists from around the world.

—Hold the HST Symposium "Experiencing the Frontiers of Biomedical Technology on March 10 and 11, 2003. This biennial event will feature a unique opportunity for participants to experience first-hand the technologies involved in tissue engineering, drug delivery systems, human-machine systems, and informatics.

—Build on the robust health of HST's educational programs and expand them, especially in the fields of bioinformatics, biomedical enterprise, and speech and hearing science and technology.

—Expand HST's research presence. Future HST research foci will be primarily directed in three areas: biomedical imaging, biomedical informatics and computational biology, and regenerative biomedical technologies.

—Continue exploration of mechanisms to optimize impact on education and research at the interface of biomedical/bioengineering in the health sciences.

—Expand HST's faculty and its visibility in research in the Harvard and MIT communities.

Martha L. Gray
Co-director
Edward Hood Taplin Professor of Medical and Electrical Engineering

More information about the Harvard-MIT Division of Health Sciences and Technology can be found on the web at http://hst.mit.edu/.

Center for Biomedical Engineering

The fusion of engineering with molecular cell biology is pushing the evolution of a new engineering discipline, termed biological engineering, to tackle challenges in molecular and genomic medicine. To facilitate interdisciplinary, cross-departmental research at this interface, the mission of the Center for Biomedical Engineering (CBE) is to combine engineering with molecular and cellular biology to develop new approaches to biomedical technology with applications to medicine.

The major research thrusts of CBE involve cell and tissue engineering, molecular and cellular interactions, and physiological systems engineering. With the addition of several new investigators this past year, over 48 CBE faculty members (from departments in MIT's Schools of Engineering, Science, and Architecture and Planning, as well as the Whitehead Institute, Harvard and Boston University Medical Schools, and the Harvard-MIT Division of Health Sciences and Technology) carry out multi-investigator research programs within CBE. This research provides a training environment for a new generation of graduate and undergraduate students in bioengineering, at the interface between engineering and biology.

To accomplish this mission, CBE has continued to enhance its connections to the industrial community in collaboration with the members of CBE's Industrial Advisory Board (IAB). The IAB is the major partner in facilitating CBE's Engineering/Biology Seed Grant Program, which provides startup funds for new ventures involving faculty teams at the engineering/biology interface. CBE's central core facilities also continue to be an invaluable aid in establishing and maintaining multi-investigator collaborations between the engineering, biological, and clinical faculty members of the center.

Among the many outstanding research accomplishments by CBE faculty this past year, new developments have emerged from Seed Grant initiatives. A major NIH-funded program project grant in cardiovascular tissue engineering and mechanobiology involves collaboration between CBE investigators at MIT and the Brigham and Women's Hospital, Boston. Endothelial cells, seeded into a novel self-assembling peptide scaffold, have been discovered to form lumens suggestive of a vascular network. Rapid 3D 2-photon imaging facilities have enabled studies of real-time cell adhesion and migration. Magnetic and optical traps have been developed to probe single-cell mechanics. The self-assembling peptide family of scaffolds has also been used in exciting new applications in tissue engineering using cartilage, nerve, liver, and pancreatic tissue. Chondrocytes in the peptide hydrogel can synthesize mechanically functional neo-cartilage, which can be further optimized by application of exercise-like compression during culture. Endothelial cells co-cultured with myocytes in peptide gel scaffolds induce myocyte junction formation and facilitate spontaneous rhythmic beating of the cell-scaffold structure.

In another project initiated via Seed Grant funding, a team of materials engineers and biologists have studied engineering models of lymphoid tissue and T cell activation, with applications to immune diseases. Micropatterning of autologous T cells and activation on unique synthetic surfaces may enable means for faster return of activated T cells to patients to combat disease.

Engineering/Biology Seed Grant Program

CBE's Engineering/Biology Seed Grant Program continues to act as a catalyst for multidisciplinary collaborations, funded by members of CBE's Industrial Advisory Board. CBE's Industrial Advisory Board meeting in May, 2002, enabled students and faculty to meet with IAB members, and present oral and poster presentations summarizing their latest research. The 2002–2003 Seed Grant awards funded projects on single-particle tracking of regulatory T cell function (D. Irvine, Materials Science and Engineering, MIT, and J. Chen, Biology, MIT), and novel anti-tumor agents—specifically, development of antibodies targeted to tumor-cell surface polysaccharides (D. Wittrup, Chemical Engineering and Biological Engineering, MIT, and R. Sasisekharan, Biological Engineering, MIT).

Move to New Facilities and Laboratories

CBE is in the final stages of preparing for its relocation to new laboratory and office space on the second and third floors of 500 Tech Square (NE47) this coming June, 2003. Significant effort this past year has been devoted to designing new state-of-the-art laboratories and core facilities. A new 500 sq. ft. cell and tissue culture facility will supplement adjacent biological and biochemical laboratories to enable CBE faculty to carry out a broad range of research projects on cell-biomaterials interactions, cell mechanotransduction, cell and molecular biomechanics, and tissue engineering with applications to nerve, liver, cartilage, pancreas, and cardiovascular systems.

The CBE Cryofixation, Freeze-Fracture/Deep Etch facility, along with the multi-photon and atomic force microscopy facilities will be relocated as well. The 500 Tech Square location will also enable increased interactions with the new Whitehead Institute-MIT BioImaging Center. This latter center will also be adjacent to CBE,

and will provide facilities for cryo electron microscopy, deconvolution light microscopy, and real time atomic force microscopy. Together, these methods will enable microstructural characterization of tissue engineering matrices and scaffold materials at the submicron level, which is critical to understanding cell-material interactions.

Alan J. Grodzinsky
Director
Professor of Electrical, Mechanical, and Biological Engineering

More information about this Center for Biomedical Engineering can be found online at http://web.mit.edu/cbe/www/.

Laboratory for Energy and the Environment

Established in 2001 in a merger of the MIT Center for Environmental Initiatives (CEI) and the Energy Laboratory, the Laboratory for Energy and Environment (LFEE) supports, coordinates, and conducts research and education on environmental and sustainability issues that influence development and welfare worldwide. The LFEE brings together collaborating faculty and staff in 14 departments to address the complex, long-term, multifaceted problems of sustainable development. LFEE multidisciplinary teams work not only on technological solutions but also on the economic, political, and social aspects associated with their realization. As a neutral broker, LFEE aims to foster constructive relationships between industry, governments, academia, and the public to seek solutions to long-range environment and energy issues. LFEE works to build better understanding of the many issues between and among developed and developing nations that arise in the context of meeting global environmental challenges. A central theme running through all of LFEE's initiatives is the role of science and technology in shaping better environmental policy at all levels in both the public and private sectors. The education program of LFEE is committed to educating the next generation of environmental and sustainability leaders worldwide via joint projects locally and nationally, and through participation in international education programs with our partners around the world.

Professor David H. Marks of Engineering Systems and Civil and Environmental Engineering is director of LFEE. He is supported by professor of chemistry Jeffrey Steinfeld, director of the LFEE Education Program; Dr. Joanne Kauffman, principal research scientist and lecturer in political science, deputy director; Stephen Connors, coordinator of multidisciplinary research; and administrative officer John O'Brien. The executive committee of the MIT Council on the Environment serves as the steering committee for LFEE.

Highlights

The founding of the Laboratory for Energy and the Environment is a milestone in MIT's efforts to facilitate the coordination of multidisciplinary research focused on environment and sustainability issues. It is the culmination of a ten-year effort to bring together researchers across MIT to cooperate on problem solving and innovative management in support of a sustainable future. LFEE supports experts in a variety of disciplines studying the complex interrelationships between energy and the environment as well as other global environmental challenges to sustainable development. The merger in 2001 means that LFEE scholars can look not just at single technologies in depth but also across technologies and can study how improving and using technologies can lead to better management and policy formation. Highlights from AY2002 reflect this constructive development.

In AY2002, LFEE attracted new faculty and additional resources to support multidisciplinary research programs, expanded its educational initiatives both locally and internationally, identified major challenges in meeting growing global transportation demands, significantly advanced ongoing work of the Energy Lab on carbon sequestration and built a consortium of sponsors to support this work, and strengthened outreach and education activities at local, national, and international levels.

The LFEE research volume for FY2002 was about $7.7 million, including sponsored research and fund accounts. LFEE research programs engage over 50 MIT faculty members and over 100 students annually.

With respect to building synergy across the Institute, the LFEE provides co-leadership for the Council on the Environment (together with MIT's chancellor, Professor Phillip L. Clay) and continues its weekly seminar series on global environment and sustainability issues. The seminar series includes presentations of work in progress on environmental challenges as well as discussions of timely issues by invited guests.

Internationally, LFEE continues coordination of MIT's participation in the Alliance for Global Sustainability (AGS). MIT's Alliance coordinators, David H. Marks and Joanne Kauffman, were instrumental in organizing the 2002 annual meeting of the AGS, which was held for the first time in a developing country, Costa Rica. The meeting attracted over 400 scholars and representatives from industry, government, and NGOs around the world. The proceedings of the meeting will serve as a resource for LFEE's own affiliates as well as other academics who are concerned with the application of scholarly research to sustainable development. In 2001-2002, AGS launched a new book series Science and Technology: Tools for Sustainable Development, published by Kluwer Academic Publishers, the Netherlands. The first two books in the series published in this academic year focus on sustainable development of the world's megacities: Air Quality in the Mexico Megacity, Luisa T. Molina and Mario J. Molina, editors; and Future Cities: Dynamics and Sustainability, Fred Moavenzadeh, Keisuke Hanaki, and Peter Baccini, editors. Through LFEE's coordinating role, MIT will host the annual technical meeting of the AGS in November 2002. This meeting will launch a new category of research partnerships for sustainable development designed to involve more stakeholders and sponsors in AGS multidisciplinary, integrated research.

In addition to the consolidation of existing programs and research projects in the former Energy Lab and CEI,

LFEE also launched a new program in FY2002 focused on bridging the gap between engineering and the social and management sciences to improve the quality of environmental regulation and policy. The Program in Science, Technology, and Environmental Policy (P-STEP) will give master's and doctoral students an opportunity to perform thesis work involving multifaceted analyses of specific regulatory issues and standards that exist or are being considered. Their research will be jointly supervised by engineering and social sciences faculty.

The graduate elective on Sustainable Energy (22.811J/10.391J/ESD66/11/371J/1.818J/3.564J) will be offered for the sixth time in the spring 2003 term. The course is taught collaboratively by faculty affiliated with LFEE and the Nuclear Engineering and Chemical Engineering departments, with the participation of other experts from within and external to MIT. Collaborators in the development of the course are finalizing a new textbook on sustainable energy, which should be available for the spring semester.

The Clean Diesel Fuel Research Initiative Program received renewed funding for a long-term research program to identify and assess the potential for significantly cleaner diesel fuels. The program is a collaboration between LFEE affiliates in the Sloan Automotive Laboratory and the Chemical Engineering Department under the University of Alaska-MIT Partnership.

The Center for Energy and Environmental Policy Research (CEEPR) continued its research focus on emissions trading and electric utility restructuring during the 2001-2002 academic year. A new collaborative research program was begun with Cambridge University concerning the relations between electric utility productivity, restructuring of electric utility regulation, and the formation of environmental regulation. Three workshops were held during the year, two in Cambridge, Massachusetts, and one in Oviedo, Spain. CEEPR is directed by Professor Paul Joskow; Dr. A. Denny Ellerman is executive director.

The Joint Program on the Science and Policy of Global Change, codirected by Professors Henry Jacoby and Ronald Prinn, continues to gain recognition as a leading center of research in its field. This recognition comes not only in the form of new associates and the continuing flow of financial support, but also in the form of more invitations to participate in expert reviews and assessments and to speak or otherwise participate in various meetings. In the past year, research and peer-review lags have been overcome and Joint Program research is appearing in a number of different journals, such as Atmospheric Environment, Climate Dynamics, The Energy Journal, Environmental Science and Policy, International Affairs, Nature, Revue de l'Energie, and Science.

The Carbon Capture and Sequestration Technologies Program, led by LFEE's Howard Herzog, continued its leadership work in assessing and researching technologies for carbon dioxide mitigation through carbon capture and sequestration. Funding for this work comes from a variety of sources, including DOE, EPRI, and the Carbon Sequestration Initiative (a nine-member industrial consortium).

The Building Technology Program, led by Professor Leon Glicksman, initiated an implementation phase of its work on cleaner building technologies in China with a demonstration project and related education and training workshops in China.

The Analysis Group for Regional Electricity Alternatives, led by the LFEE's Stephen Connors continues to apply it multi-attribute tradeoff-analysis approach to the assessment of environmentally responsible energy technology portfolios. AGREA currently supports research with several AGS and MIT/AGS projects, including the Mexico City Integrated Assessment, the China Energy Technology Program, new projects in Northern Europe and Romania, and investigations of renewable energy in the United States and various developing countries.

Component Programs

In 2001-2002 LFEE carried out its mission by combining and building on the intellectual resources of its predecessors, CEI and the Energy Lab.

Component programs in 2001-2002 were: the Alliance for Global Sustainability (international focus); the MIT/AGS Consortium on Environmental Challenges (focus on science and technology in environmental decision making); the Carbon Sequestration Initiative; the Center for Airborne Organics; and the LFEE Education Program. Research programs are also supported in the Center for Advanced Nuclear Energy Systems; the Sloan Automotive Laboratory; the Building Technology Program; the Center for Energy and Environmental Policy Research; the Materials Systems Laboratory; and the MIT Center for International Studies.

Alliance for Global Sustainability

AGS-supported research brings together scholars from the three founding partner universities (MIT, the Swiss Federal Institute of Technology, and the University of Tokyo), the fourth partner, Chalmers University of Technology, Sweden, and partners from industry, NGOs, government, and other leading academic institutions to address complex environmental problems that transcend geographical and disciplinary boundaries. In AY2002 AGS held its first meeting outside the boundaries of its member institutions as participants convened in a developing country, Costa Rica. The Instituto Centro Americano de Administracion de Empresas (INCAE) was the host for the meeting, which attracted over 400 scholars from the AGS members,

INCAE, and other Latin American universities, as well as invited guests from industry, government, and civil society. Preceding the annual meeting, the AGS Governing Board approved funding for 13 new projects over the next two years. This new funding brings the number of international multidisciplinary research projects supported by the AGS to over 60.

AGS projects fall within three major focus areas: water, energy, and mobility. In addition, some of the projects address crosscutting issues such as urban systems, cleaner technologies, policies and institutions, and communications and outreach for sustainable development. AGS project leaders have raised more than $20 million to supplement these projects and related sustainability research at the partner universities. More than 200 graduate students in the member schools have participated in AGS research initiatives that are characterized by strong integration of multidisciplinary and comparative geographical perspectives on complex sustainability issues. Through this program many students have participated in academic exchanges with member institutions and their partners in developed and developing countries and completed numerous doctoral theses in each of the focus areas.

In addition to its research programs the AGS supports education and outreach initiatives to raise awareness of the important role of science and technology in meeting the sustainability challenge to future development and to equip the next generation of leaders with the knowledge and skills they need to address such challenges throughout their careers. Among these is the AGS-supported Youth Environmental Summit (YES) in Braunwald, Switzerland. In 2001-2002, the program brought 40 graduate students from over 30 countries to two two-week intensive study programs on sustainability with a focus on implementation of Agenda 21.

Professor David Marks and Dr. Joanne Kauffman are the MIT coordinators for the AGS. Further information is available at the AGS web site at http://www.globalsustainability.org/.

MIT/AGS Consortium on Environmental Challenges

In 2001-2002, the Consortium on Environmental Challenges created stronger ties with the international AGS program with a regional focus on environment and sustainability issues. This integration provides greater international reach and synergy in the programs initiated at MIT, as well as enhanced visibility through the AGS International education and outreach programs. The MIT/AGS focuses on the role of scientific and technological knowledge in environmental decision making and seeks to provide recommendations for improving the scientific foundation for policies and decisions that affect the global environment. The MIT management team for the program includes Professors David Marks, Mario Molina, and Kenneth Oye, and Dr. Joanne Kauffman. The goals of the program are to:

- assess global environmental challenges and their impact on ecosystems, economic development, and health.
- identify and contribute to the knowledge needed to meet those challenges.
- improve policy making through use of unbiased knowledge—scientific, technological, and socio-economic.

MIT/AGS-affiliated scholars from across the Institute are assessing the state of knowledge needed to effectively meet global environmental challenges by focusing on specific issue areas.

In 2001-2002, linkages focused on energy choices for the future including sustainable building technologies, safety of nuclear energy systems, and carbon management and sequestration; the automobile and sustainability with an emphasis on options for future road transportation; water for a sustainable future; air quality in the world's burgeoning megacities (case study on Mexico City); and ways to improve decision making under conditions of uncertainty.

Through this initiative, researchers seek to understand how to increase the role scientific evidence and technological knowledge play or can play in meeting the challenges posed by environmental risks to economic development and social welfare.

The Mexico City Integrated Assessment Project is an important example of how the best science and technology can be applied to help solve contemporary environmental problems. The program, which is supported by the Mexican government as well as through the MIT/AGS consortium and other sources, is working with public officials and stakeholders on ways to improve air quality in Mexico City and contribute to the solution of related regional and global air quality problems. The project includes identification of sources and effects of air pollution in Mexico City through high quality science carried out at MIT and with its partners in Mexico and elsewhere. The project is led by Professor Mario Molina and Dr. Luisa Molina. More information can be found at the project's web site at http://eaps.mit.edu/megacities/.

Major accomplishments of the MIT/AGS consortium in 2001-2002 include completion of a major study on mobility in the 21st century in conjunction with the World Business Council on Sustainable Development; the organization of major workshops and executive education training in Mexico City; and completion of background studies on incentives to industry to recognize potential competitive

advantage in environmental regulation. A number of completed theses supervised by the Center for International Studies under the auspices of the MIT/AGS program address new approaches to environmental decision making and policy formation. The groundwork carried out in the consortium and with CIS researchers underlies planning for the new LFEE program on Science, Technology, and Environmental Policy.

The MIT Consortium on Environmental Challenges was created in October 1997, when MIT and Ford Motor Company announced a collaboration focusing on education and research. As a component of this partnership, Ford pledged $5 million over five years to initiate and support the consortium. Commitment to continued support for the second five year phase was announced in 2002. The advisory committee for the program in 2001-2002 included sponsors at ExxonMobil, 3M, DuPont, Caterpillar, and Shell.

Carbon Capture and Sequestration Technologies Program

The field of carbon capture and sequestration is attracting much interest due to increasing concerns about global climate change. Our continuing work on carbon sequestration technologies focuses on three areas: assessment, education/outreach, and basic research. Howard Herzog leads this effort. Some of our key research thrusts are:

- Ongoing assessment and outreach work for the National Energy Technology Laboratory (NETL) of the DOE
- An integrative assessment of carbon sequestration technologies co-funded by the DOE's Office of Fossil Energy and Office of Science (includes collaboration with Professor Jacoby and the Joint Program). This project ends in January 2003, but a follow-on project investigating penetration rates of sequestration technologies has been funded.
- An international collaborative effort between Japan, Norway, Canada, Australia, and the United States on CO2 ocean sequestration funded by NETL. The objective of this project is to investigate the technical feasibility, and improve understanding, of the environmental impacts of CO2 ocean sequestration (in collaboration with Dr. Eric Adams of the Parsons Laboratory).
- The Carbon Sequestration Initiative, an industrial consortium on carbon management under the Energy Choices Program. Our nine members are American Electric Power, ChevronTexaco, Electricité de France, EPRI, ExxonMobil, Ford Motor Company, General Motors, Peabody Energy, and TotalFinaElf (France).
- An investigation of social factors that will affect the future of carbon capture and sequestration technologies has been launched. These factors involve siting, permitting, regulatory, environmental justice, etc. We hope to accomplish some of this work through the AGS.
- A major new effort to develop a carbon sequestration information system (using a Geographic Information System (GIS) as a platform) has been funded by DOE fossil Energy.

Center for Airborne Organics

Professor Jack B. Howard directs the EPA Center on Airborne Organics. A major goal of this center is to better understand pollution of ambient airsheds by energy and other industrial sources and to use that understanding to prescribe new means of detecting and tracing organic pollutants and new methodologies for preventing pollutant emissions altogether. Specific projects focus on sources, atmospheric transport and transformation, monitoring, and engineering controls for organic pollutant vapors and aerosols. To provide a strong group of experts to address these issues, the center operates as a consortium of MIT, the California Institute of Technology, and the New Jersey Institute of Technology. Professors John H. Seinfeld (Caltech) and Robert Pfeffer (NJIT) are associate directors. MIT scientists participating in center research projects have included Professors Paul I. Barton, Wai Cheng, William H. Green, John B. Heywood, Jack B. Howard, Mario Molina, and John B. Vander Sande, and Dr. Arthur LaFleur. For several years, the center hosted an annual summer symposium on high-visibility technology and policy topics in ambient air pollution. In July 2001 the focus of this meeting was Exporting and Importing Air Pollution: Regional and Global Transport. The meeting was chaired by Dr. Robert Slott, consultant to the LFEE. Reports of the center and of Summer Symposia are available on the center website. The ten-year lifetime of the center will be completed September 30, 2002, and a comprehensive Final Technical Report summarizing the research achievements and public policy impacts of the center will be issued.

Energy Choices

A generous gift of $1,350,000 over two years from the V. Kann Rasmussen Foundation allowed MIT to launch broad research initiatives in 1997 focusing on innovative energy solutions. In 2000, the foundation extended its support by $1 million over a two year period. These funds are used in conjunction with funds raised from corporate and other sponsors to pursue important research in strategic areas of opportunity.

Electric Sector Research Activities

LFEE research in the area of strategic planning for energy infrastructures and environmental performance is centered

on the Analysis Group for Regional Electricity Alternatives (AGREA), led by Stephen Connors. The scenario-based multi-attribute tradeoff-analysis approach, developed in the 1980s by Energy Lab researchers, is the primary tool used by AGREA. Current group projects include studies of electricity alternatives in China, Northern Europe, and Romania and an integrated assessment of the air pollution reduction alternatives for the Mexico City Metropolitan Area. In addition to the multi-attribute tradeoff-analysis approach, all three case studies include interaction with local decision makers to ensure that the research is relevant, attuned to local conditions, and has a better chance of influencing the decisions of local officials.

These elements also characterize the Mexico City investigation. This project, sponsored by the Consortium on Environmental Challenges, includes numerous Mexican institutions and researchers, as well as scientists from the Harvard School of Public Health. On the MIT side, researchers are drawn from the Departments of Earth, Atmospheric, and Planetary Sciences, Civil and Environmental Engineering, Chemical Engineering, and Urban Studies and Planning, the Center for Transportation Studies, and the Center for International Studies, and research units from the former Energy Lab. AGREA plays a central role in this effort due to its scenario planning approach and its participants' extensive experience in interacting with local stakeholders.

Other AGREA research activities include a project for the US Environmental Protection Agency to assess the avoided emissions potential of solar photovoltaics (PVs) across the United States. This research entails comparing where and when kWhs from PVs generate electricity to units based on fossil fuel and other sources operating on the grid in order to assess their long-term contributions to criteria pollutant and greenhouse gas reductions. The databases for historical avoided emissions will provide a resource for investigators comparing the emissions-reduction potential of other renewable energy sources and energy conservation.

Research in competitive power systems continued in AY2002. Led by Dr. Marija Ilic, research in this area included the ABB-sponsored project "Distributed Power Industry of the Future." Research thrusts, which also included intellectual participation from faculty in the Laboratory for Information and Decision Systems (LIDS), included the development and application of congestion management structures and computational capabilities for regional grid operators, price forecasting techniques for generators and power marketers, and revised criteria for measuring the adequacy and reliability of power supplies. The distributed power industry project focuses on the technical, economic, and regulatory challenges that distributed resources pose to distribution system stability. The project is also addressing alternative business models and regulatory structures, which may enable or constrain the deployment and use of consumer based electricity generation, storage, demand control, and power quality enhancement. Also participating in the distributed power project are Professors Paul Kleindorfer from the University of Pennsylvania's Wharton School of Business, and Ingo Vogelsang from Boston University.

Political Economy and Technology Policy Group

The Political Economy and Technology Policy Group, led by Professor Kenneth Oye, is a joint program of the LFEE and the Center for International Studies. Its purpose is to identify means to improve the quality of public and private responses to critical environmental problems by combining expertise on problems of political economy with fundamental understanding of scientific and technical issues. The Political Economy and Technology Policy Group's research focuses on three key areas for improving environmental decision making. First, the use of scientific information in public policy making. The intent is to identify methods for more robust and integrated assessments of policy options and for credible risk assessments of risks in areas of environmental policy controversy. Second, the capacity of political institutions to adapt to new information. Third, assessment of the private effects of public environmental policies, with specific attention to the competitive position of firms, sectors, and nations. The Political Economy and Technology Policy Group currently is launching a study of links among regulation, the utilization of technologies, and industrial structure.

In 2001-2002 the Political Economy and Technology Policy Group was engaged in a broad range of activities, some of which were jointly funded by AGS and other institutions. This research group has:

—Completed short studies on automobiles and fuels and food processing. These studies will be synthesized and expanded with comparative work in other sectors in the future.

—Completed a book-length manuscript that examines US, EU, and Japanese responses to a set of common environmental and safety problems. The book addresses (a) the effects of regulatory diversity on environmental performance as well as trade openness and (b) the causes of diversity in regulations. The work on this book was jointly undertaken by faculty and research staff from MIT, ETH, the University of Tokyo, Carleton University of Ottawa, and Stanford University.

—Worked with the Finnish Environmental Institute in a comparative analysis of the pulp and paper industries in Scandinavia and the US. The purposes are to assess the implications of divergent, national regulatory regimes on environmental performance in that industry; and to assess the implications of divergent R&D programs and

investment incentives cross-nationally as they affect long term environmental performance in the pulp and paper industry.

—Worked with the Ford Motor Company in examining potential environmental effects of accelerating the phase-in of cleaner diesel fuels and of applying emerging heavy duty vehicle engine and after-treatment technologies to light duty vehicles. The research team is planning to work with John Heywood's automotive group and Greg McRae's chemical engineering group in assessing these issues. A workshop to examine these options is scheduled for mid-November 2002.

—Contributed significantly to developing the program that underlies the P-STEP initiative by assisting in design, proposal writing and workshops intended to establish that new program.

—Worked closely with the carbon sequestration initiative and other LFEE research projects to ensure inclusion of policy dimensions in assessments of technology solution options.

Affiliated Research

Energy Issues in China

In the past year, LFEE continued to invest in projects that support China's efforts to improve energy efficiency in buildings, and in projects to improve the safety and reliability of the expanding nuclear industry in China and elsewhere. The focus of the sustainable buildings project is on residential buildings in large Chinese cities beginning with Beijing and Shanghai. The project has emphasized the use of materials and building styles appropriate and available in the local area. In 2001-2002, the research entered an implementation and outreach phase with workshops and demonstrations projects organized for stakeholders in China. Two MIT research groups, the Building Technology Program, and the Center for Advanced Nuclear Energy Systems, include research on conditions in China among their initiatives.

Building Technology Program

Faculty and students in building technology are conducting a major program of sustainable building design and technology for developing countries. Participants are actively cooperating with colleagues at Tsinghua University and Tongji University and Chinese developers and designers. The focus is on residential buildings in large Chinese cities. Projects include the design of four high-rise residential structures in Beijing, two mid-rise multi-story housing units in Shanghai's Taidong residential quarter, and a low-rise residential community in Shenzhen City. The goal of these projects is the development of demonstration buildings that use appropriate technologies and designs as teaching tools and examples for future projects in Chinese cities. New technologies such as night cooling, solar-driven dehumidification, and ground-coupled heat pumps are being evaluated, as is the incorporation of traditional technologies such as shading and natural ventilation. A book on sustainable energy for Chinese buildings detailing the findings of these studies is being prepared; it will be published as part of the AGS series.

MIT, ETHZ, and Chalmers are cooperating with Tsinghua University and the Ministry of Construction in China to develop new sustainable guidelines for Chinese housing. The proposed guidelines will be included in a web-based tool for designers and developers. Follow-up studies of housing projects in several Chinese cities will also be undertaken.

The building technology group also is cooperating with colleagues at the University of Tokyo in a study dealing with reduction of pollution from megacities such as Tokyo or Shanghai. This technical work is being carried out in cooperation with the University of Tokyo and the Swiss Federal Institute of Technology. In this project, technologies such as ground source heat pumps and advanced facades are being evaluated. Ground source heat pumps use low grade geothermal energy to improve efficiency for both heating and cooling of buildings. The ground source air conditioner, which stores or extracts heat underground, will significantly reduce urban heat island effects in the summer. We have undertaken a comprehensive study of advanced building facades that have air circulation between multiple glazing as well as blinds to control solar input and daylighting. These facade systems, when properly used, will reduce energy for air conditioning as well as artificial lighting. They will also improve interior comfort and ventilation. The results have been included in a web-based design tool that can be used by designers in the conceptual design stages.

The building technology group has begun a joint study with Cambridge University under the Cambridge-MIT Institute. This research focuses on sustainable commercial buildings in the UK and US. It involves design and technology studies for large new projects; detailed monitoring of existing buildings; and fundamental and applied studies of new energy technologies such as natural ventilation to replace or reduce energy requirements for air conditioning.

Center for Advanced Nuclear Energy Systems

Prior to the merger of the Energy Laboratory and the Center for Environmental Initiatives, the Energy Lab and the Nuclear Engineering Department jointly developed a new Center for Advanced Nuclear Energy Systems (CANES). The center aims to create research concepts for nuclear energy systems that promise more favorable economics, safety, proliferation resistance, and environmental impact. The center's programs involve

development and application of methods for the design, operation, and regulation of current and advanced nuclear reactors and fuel cycles. This requires advances in knowledge about traditional scientific and technical disciplines, modern methods of systems reliability, probabilistic safety analysis and decision analysis, together with human interactions and management science. Professor Mujid S. Kazimi is the director of CANES.

Center programs involve four major thrusts: developing advanced reactor plant technology options; investigating alternative nuclear fuel cycles from the economic and environmental points of view; providing new methods to enhance operations of nuclear power plants in a risk-informed regulatory framework; and assessing the role of nuclear energy in a sustainable world.

The center collaborates with DOE's Idaho National Engineering and Environmental Laboratory (INEEL,) which has continued to support advanced reactor research projects at MIT. This was the fifth year in which INEEL had given MIT a total of nearly $1 million tied to about $1 million funding at INEEL for the development of advanced reactors. Four projects were funded under this initiative: the Modular Gas Cooled Reactor under the direction of Professor Andrew Kadak; the Lead-Bismuth Cooled Actinide Fueled Reactor (AFR) under the direction of Professor Todreas; Advanced Fuels for Light Water Reactors under the direction of Professor Kazimi; and the Fast Gas Cooled Gas Turbine Reactor under the direction of Professor Driscoll.

The center established a Collaborative Research and Development Agreement (CRADA) with the US Department of Energy under which the two will cooperate on ways to clean up fuel scraps from fuel facilities owned by Global Fuels, Inc. The CRADA also involves Brookhaven National Laboratory and a Russian fuel processing factory in Ulba, Kazakhastan.

A collaboration that started in 1998 between MIT and Tsinghua University that aims to provide China's growing nuclear energy sector with a firmer foundation to develop nuclear safety standards and techniques for enhanced safety features of operating plants has continued. Professor Golay and his student Yi Sui visited operating nuclear plants in China and used the information they gathered in their research, which aims at defining performance indicators for the power plants. Professors Kadak and Kazimi visited the recently completed gas-cooled pebble bed research reactor and exchanged information about the codes used at MIT and Tsinghua University to simulate the behavior of the reactor.

Sloan Automotive Laboratory

Many of the laboratory's projects involve quantitative and cross-disciplinary study of complex energy and environmental systems. The laboratory is directed by Professor John Heywood with participation from Professor Wai Cheng, Professor Doug Hart, Professor James Keck, Dr. David Schmidt, Dr. Tian Tian, Dr.Victor Wong and Professor William Green of the Chemical Engineering Department. It continues to pursue promising research to improve engine performance, efficiency, and fuel utilization in internal combustion engines and reduce adverse emissions. Focusing on new engine and fuel technologies, the Engine and Fuels Research Consortium continues to explore critical fuel/air mixture preparation and emission formation mechanisms in developing engine concepts, with potential application to both gasoline and diesel engines. Complementing the engine and fuels studies, the Consortium on Lubrication in Internal Combustion Engines involves major engine component and lubricant manufacturers, in addressing issues in oil consumption and engine friction reduction. Some members in these consortia also sponsor separate research projects on related topics of specific application to the individual sponsors. For example, Professors Wai Cheng and John Heywood work with Ford Motor Company on three projects related to engine transients: fuel/air mixture preparation behavior during start up, emission benefits of engine operation in hybrid electric vehicles, and actual in-use vehicle emissions in stop and go traffic.

Sloan Laboratory researchers are also involved in assessing new vehicle and propulsion system technologies for future road transportation use. The Sloan Laboratory also engages actively in basic combustion research on advanced engine systems with US DOE support, and in engine emission research with support from the EPA Research Center on Airborne Organics. The initial phase of the Clean Diesel Fuel Research Initiative Program, originally a collaboration between the Energy Laboratory and the Chemical Engineering Department under the University of Alaska-MIT Partnership, is receiving substantial industry support. The initial goal is to identify and assess the potential for significantly cleaner diesel fuels. Plans for a longer term research program have been developed and are expected to be funded shortly. The proposed research will complement extensive fuel-testing programs being conducted elsewhere and will address engine technology/fuels interaction, fuel-processing technology, and special environmental and economic factors.

In a joint project with the Plasma Science and Fusion Center, Professor John Heywood and Sloan Automotive Laboratory graduate students are exploring the opportunities for lean operating spark ignition engines, in which a plasmatron device—an electrical discharge-initiated fuel reformer—supplies hydrogen to enable the lean burn. A license to develop this technology has been taken out by ArvinMeritor, and a substantial cooperative research and development program with DOE; ArvinMeritor funding is in progress.

Professor Heywood and Dr. Malcolm Weiss completed an assessment of new vehicle and fuel technologies for future road transportation, considering the increasing concerns about limiting both greenhouse gas emissions and criteria pollutants such as particulates and nitrogen oxides. The work started with a critical review of existing assessments (many of which are partial system views with a variety of different assumptions), and then conducted a life cycle assessment of potential fuel/vehicle systems for the 2020 time frame. Finally, the implications of transitions to these future transportation technologies to each of the major stakeholders in the transportation industry, including customers and the government, were evaluated. The focus is to identify barriers and opportunities for accelerating the adoption of such new technologies where they offer advantages relative to the evolving fleets of cars and trucks. A report was and published in 2001, following an interactive workshop that focused on the report and identified options for pathways for the future. This work is being extended in 2002 to consider the effects of more optimistic assumptions about future performance of fuel cells. A program on issues in freight transportation is also being planned.

Center for Energy and Environmental Policy Research

The Center for Energy and Environmental Policy Research (CEEPR) is an activity jointly sponsored at MIT by LFEE, the Department of Economics, and the Alfred P. Sloan School of Management. CEEPR funds policy-related research in energy and environmental economics. The center receives financial support from corporate sponsors, the US Environmental Protection Agency, and the Cambridge-MIT Institute.

CEEPR research is focused on evaluating the functioning and performance of markets created for the provision of environmental goods and for providing electricity and associated services. Most of the environmental research is concerned with the relationship between SO2 allowance trading, emission reductions, and compliance under the US Acid Rain Program. CEEPR's research in electricity examines the functioning and performance of new markets being created in many countries as the electric utility sector is restructured. Particular emphasis is placed on how restructuring decisions with respect to asset ownership, transmission access, and customer choice shape these markets and the provision of electricity to consumers.

Joint Program on the Science and Policy of Global Change

This program, co-directed by Professors Jacoby of the Sloan School and Prinn of the Department of Earth, Atmospheric, and Planetary Sciences, draws on MIT's traditional strengths in science and economics to conduct the serious interdisciplinary work needed to provide a basis for global climate policy. The now eleven-year-old Joint Program is one of the world's leading centers for the integrated assessment of climate change. An MIT Integrated Global Systems Model, developed by program researchers, provides a facility for research on the climate issue and assessment of policy proposals. An interdisciplinary team of faculty, professional staff, and graduate students carries out the work, and it produces a continuing flow of reports, articles, student theses, and professional and public presentations on the science and policy of global warming. Four US government agencies, 20 corporate sponsors in North America, Europe, and Japan, and one foundation support the work.

Education and Curriculum Initiatives

With the establishment of LFEE, environmental education initiatives at MIT found a new organizational home. To reflect LFEE's commitment to environmental education, the lab established the LFEE Education Program, which pursues the agenda previously undertaken by the Program on Environmental Education and Research (PEER). Professor Jeffrey Steinfeld, director of PEER, continues as director of the LFEE Education Program, and Dr. Amanda Graham was hired to the new position of LFEE education program manager in 2001.

The mission of the LFEE Education Program is to enhance environmental literacy and strengthen the environmental dimension of educational experiences, particularly among the leaders of tomorrow's science and technology communities. The program is dedicated to increasing awareness of the complexity of environmental and sustainability challenges, and to increasing the multidisciplinary capacity of learners to respond effectively to these challenges. A special challenge of the mission of the LFEE education program is to ensure that environmental issues and concerns are part of the education of every MIT student, not just those who will become environmental scientists, engineers, and planners. All students at MIT need to understand what is happening in the world that we inhabit, to be aware of how human activities are influencing this world, and to acquire a sense of responsibility for the planet and its inhabitants.

Towards this end, the program has identified three broad constituencies and conducts a range of activities to meet special goals for each group:

The MIT Community

The goal is to improve environmental literacy and strengthen education on the environment at MIT. LFEE is

—supporting efforts by the MIT Council on the Environment to improve coordination and coherence among academic, research, and activity offerings for undergraduates (including aiding with the development of a cluster of environmental minors and coordinating with

Admissions, Career Counseling, and the UROP Office to better serve prospective students and future alumni).

—supporting and participating in the development of subjects and programs for environmental majors and graduate students.

consulting with the Environmental Programs Office on the content and structure of the research and education portion of the revised "Environment at MIT" web site.

—managing fellowship programs for scholars in sustainability, including the Knut and Alice Wallenberg Foundation Postdoctoral Fellowships for the Environment and Sustainability (for promising Swedish scholars), and the Martin Family Fellowship Program in Sustainability (for outstanding upper-level MIT graduate students). Associated with these programs, special lectures are offered to the MIT community. In September 2002, Jacob Wallenberg, vice president of Investor AB, will speak on "The US and EU: Not as far apart as you think."

—maintaining an Environmental Class Listing web site to aid undergraduate and graduate students in searching for courses with environmental content in a wide range of topics.

The Local and Regional Community

LFEE's goal is to cultivate the improvement of math, science, and technology education, particularly in the Cambridge Public Schools by

—coordinating ongoing activities of Urban Focus: MIT-Cambridge Public Schools Collaboration on Education for the Environment, a supplemental environmental project undertaken by MIT as part of its consent decree with the US Environmental Protection Agency and the US Department of Justice.

—supporting the incorporation of environmental education into the new science-focused Tobin School (K-8, Cambridge).

—enhancing coordination between MIT's environmental, scientific, and technological expertise and the capacity of Cambridge public school students to excel in meeting state standards (grant proposal to National Science Foundation submitted May 2002, pending approval)

exploring professional development opportunities for local school teachers in environmental topics.

The International and National Communities

LFEE is fostering multidisciplinary international environmental education that integrates technological and social perspectives by

—partnering with AGS universities to plan and implement the annual Youth Environmental Summit (YES), with a special focus at MIT on managing the ongoing internal evaluation of YES.

—planning and facilitating an education workshop as a key component of the AGS Technical Meeting (November 2002), in coordination with international AGS Education Committee partners and Dr. Joanne Kauffman.

—conducting an education research project, Delivering Research Results to the Educational Process, in coordination with international AGS Education partners (AGS-funded project).

—participating in the AGS Communications Subcommittee developing instructional modules and professional development activities for instructors of environmental technology and science at the community college and high school levels, in collaboration with the Advanced Technology Environmental Education Center (ATEEC), a National Science Foundation-funded program).

The three sets of objectives of the LFEE Education Program are conceived to be interconnected and interdependent. Meeting the challenges of environmental sustainability requires that lessons learned in international environmental research and education inform the environmental dimension of education domestically as well.

David H. Marks
Director
Morton and Claire Goulder Family Professor
Professor of Civil and Environmental Engineering
Professor of Engineering Systems

More information about the Laboratory for Energy and the Environment can be found on the web at http://lfee.mit.edu/.

Francis Bitter Magnet Laboratory

The Francis Bitter Magnet Laboratory (FBML) has continued to make notable advances in several areas of science and engineering involving high magnetic fields. The research program in magnetic resonance (nuclear magnetic resonance (NMR), and electron paramagnetic resonance (EPR)) has continued to grow and remains the largest effort at the FBML. The program is funded primarily by the NIH and DOE, and involves ~20 NMR and EPR magnets and spectrometers.

A few of this year's highlights:

—Professor Robert G. Griffin, together with Professor Gerhard Wagner of Harvard University, continue to operate the MIT/Harvard Center for Magnetic Resonance, a collaborative research effort between MIT and Harvard Medical School. The center is supported by an NIH research resource grant that was renewed for five years.

—Professor Cory, Dr. Havel and their colleagues continue to make advances in the theory, practice and implementation of quantum information processing. In particular they have implemented a solid state version of an NMR quantum information processor that promises to provide more precise control over larger Hilbert spaces than is available in the liquid state.

—Professor Cory (editor in chief) and Dr. Havel (managing editor) have formed a new journal, Quantum Information Processing, published by Kluwer Academic. QIP is an international forum for the publication of peer-reviewed papers on all aspects, theory and experimental, of quantum information processing.

—Dr. Yukikazu Iwasa has successfully operated the first flux pump—a digitally flux injector—for use in slightly dissipative NMR magnets. Dr. Iwasa has also completed the first low- and high-temperature superconducting NMR magnet.

—Dr. Jagadeesh Moodera has continued to strengthen his research efforts in condensed matter physics through collaboration with various universities and industries, as well as the ONR and NSF. In addition, he has continued his mentoring of graduate students, undergraduate and high school students by providing research opportunities within his lab. Dr. Moodera has been elected as the co-chairman of the Gordon Research Conference on Magnetic Nanostructures meeting for the next four years.

Research Activities

Professor David G. Cory

Quantum Information Processing (QIP)

Professor Cory and his students continue to explore NMR approaches to quantum information processing through a set of collaborations with Dr. Timothy F. Havel (NED), Professor Seth Lloyd (Mechanical Engineering), Professor Eddie Farhi (Physics), Dr. Raymond Laflamme (University of Waterloo), Dr. E. Knill (LANL), and Dr. J. Yepez (AFRL). We have developed new means of coherent control (in the presence of decoherence and incoherent interactions) that achieve experimental fidelities of 0.99.

We have constructed a new scheme for extending the success of NMR approaches to QIP to larger systems via a solid state device capable of coherently controlling 10–30 qubits. We are using this scheme to explore quantum complexity and the transition from quantum to classical dynamics.

We have investigated quantum chaos with the aims of developing experimental signatures which differentiate regular from chaotic dynamics, and showing the connection of chaotic couplings to an environment with decoherence.

We have defined and experimentally implemented a new model of quantum decoherence that requires a minimum number of quantum resources. This system is coupled to a simulated quantum environment that is periodically and randomly re-dressed to introduce user-defined decoherence.

NMR of Heterogeneous Semi-Solids

In collaboration with Dr. S. Singer, and Dr. Pabitra Sen of Schlumberger Doll Research Laboratory, we have continued to explore the structure and fluid dynamics of complex media. The heterogeneity of the sample itself sets up a signature of the local geometry which provides a simple and direct means of characterizing micron scale structures. Knowledge of this provides insight into cellular differentiation and fluid transport through complex structures.

NMR Imaging of Neuron Structure and Function

Dr. Alan Jasanoff (a Whitehead fellow at MIT) has developed the tools to enable the neuron structure and response of blow flies to be explored at high resolution via NMR microscopy. The use of blow flies provides a stable and well characterized test bed, while simultaneously permitting near cellular resolution in the NMR. This in turn enables the observation of neuron activity in living/functioning tissue with the markers being directly traceable to neuron biochemistry. Dr. Jasanoff is developing a series of exodenous markers of biochemical response for neuroscience.

Professor Robert G. Griffin

A web site describing some of our research can be found online at http://web.mit.edu/fbml/cmr/griffin-group/.

High Frequency Electron Paramagnetic Resonance (EPR)

The 140 GHz pulsed EPR spectrometer is routinely used for Echo Detected (ED) experiments as well as Electron Nuclear Double Resonance (ENDOR). In particular, the ENDOR experiment is used to measure protons and also low gamma nuclei such as deuterium. We recently demonstrated the high resolution of the ENDOR experiment by measuring the coupling arising from a hydrogen bond of an exchangeable proton to the tyrosyl radical in Ribonucleotide Reductase (RNR) from yeast. The analysis included an estimate of the bond length and orientation. All measurements were done at low temperature with a new flow cryostat which operates in the range of 1.2 to 420K.

Structural Studies of Alzheimer's Disease Amyloid

Amyloidoses are a group of disorders due to peptide or protein misfolding and characterized by the accumulation of insoluble fibrillar protein material in extracellular spaces. Sixteen different peptides are known to form amyloid-like aggregates, and are involved in several diseases. ß-amyloid (A) in Alzheimer's disease; the prion protein PrPc, converting to PrPsc and leading to the transmissible spongiform encephalopathie; and the synuclein protein, responsible for Parkinson's disease.

During the last two years, we developed methods to obtain large amounts of fibrillar peptide material. And to maintain this material in a state suitable for MAS NMR experiments. We have used these techniques in a collaborative study of the structure of 11-mer fibrillar peptides in collaboration with Professor Chris Dobson of Cambridge University. The peptides are derived from transthyretin and to date have yielded excellent spectra. We are presently in the process of assigning these spectra and plan by next year to have a structure of a fibrillar system.

Dynamic Nuclear Polarization

The 140 and 250 GHz DNP spectrometers continue to operate reliably and routinely, allowing us to pursue new applications of DNP. Significant advances have been made in combining MAS with DNP. In the past year, one- and two-dimensional MAS/DNP spectra have been measured at both field strengths on a variety of samples ranging from amino acids to membrane protein systems. Sensitivity enhancement factors in the range of 50 to 60 have been achieved at ~90K, and we are developing a MAS system for lower temperatures to bring further sensitivity gains. A new project is underway, with promising results even at this early stage, in the application of DNP sensitivity enhancement to solution-state NMR. Signal enhancements of ~150 have been obtained for 31P in a solution of triphenyl phosphine at 5T. At present these represent the highest frequency DNP experiments ever performed, and more importantly suggest that even higher frequency operation will be successful. In collaboration with the PSFC we have designed and are constructing a 460 GHz gyrotron that will be used in conjunction with the 700MHz widebore magnet

Dipolar Recoupling

Over the last decade we have been heavily involved in the development of techniques to measure distances and torsion angles in solids. The goal is to be able to determine the structure of membrane proteins, amyloid fibrils, etc. with solid state NMR. This past year we developed a method for simultaneously measuring multiple 13C-15N distances in uniformly labeled materials, and demonstrated the method successfully on a small peptide. We are also developing methods for measuring 13C-13C distances in uniformly labeled materials. We anticipate that with increased sensitivity available from DNP experiments these methods will be applicable to a large number of systems not accessible to solution NMR and X-ray crystallographic investigations.

Center for Magnetic Resonance

The Center for Magnetic Resonance has completed its 26th year of operation as a facility open to scientists needing access to high field NMR equipment. During this year, 38 projects were worked on by 81 investigators, from departments within MIT including Chemistry, Physics and Nuclear Engineering, as well as users and collaborators from institutions outside of MIT such as Harvard University, Brandeis University and Brigham and Women's Hospital. Work resulted in 46 publications in print or in press.

Highlights of work conducted at the center include advances in high frequency dynamic nuclear polarization with magic angle spinning (MASDNP), structure determination of large proteins, studies of long range order in unfolded proteins and high frequency EPR and ENDOR.

The Center for Magnetic Resonance recently received approved funding from NIH for 900 MHz spectrometers. The 900s will be operated as part of the CMR. In addition we anticipate applying for widebore 800 NHz NMR systems in the next year or two.

Dr. Yukikazu Iwasa

We are involved in research and development of superconducting magnet technology, particularly of high-temperature superconductor (HTS). Specific HTS-related projects with which the Magnet Technology Division (MTD) is currently involved include development of a flux pump for NMR superconducting magnets that incorporates HTS inserts; phase 1 project of a three-phase, six-year program to complete a 1-GHz NMR magnet that includes

an HTS insert; study of stability/protection of HTS magnets used in electric power devices; development of a "noise free" NMR magnet system. Topics 4 and 5 apply solid nitrogen technology recently developed by the MTD. These projects are briefly summarized below.

Flux Pump for NMR Superconducting Magnets

Flux pump is considered a viable technology for achieving the 1-GHz milestone. By allowing precisely metered quantities of magnetic energy to be injected into a slightly dissipative superconducting coil, e.g., an HTS insert coil in a 1-GHz magnet system, a flux pump can make the dissipative coil operate in an effectively persistent mode.

Since June 1, 2000, we have designed, built, and successfully operated a model flux pump to confirm its experimental results with analysis. Presently, we are designing a prototype flux pump that will be coupled to a Phase 1 LTS/HTS NMR magnet presently under construction in the MTD, described below.

HTS Insert Coil for 1-GHz NMR Magnet

The MTD is presently undertaking phase 1 of a six-year, three-phase project to complete a high-resolution 1-GHz NMR magnet. In each phase, an HTS insert coil will be designed, built, and operated in a background LTS magnet. Since October 1, 2000, we have nearly completed the phase 1 system and are ready to begin the phase 2 system in early 2003.

Solid Nitrogen Technology

The large heat capacity of solid nitrogen in the temperature range 10–60K is considered beneficial for operation of HTS magnets in some applications.

Stability/Protection of HTS Magnets

The large heat capacity of solid nitrogen impregnating the winding of an HTS magnet in an electric power device limits the temperature rise in the HTS winding subjected to fault-mode overcurrent pulses. We are investigating quench/recovery processes of YBCO-coated tape subject to transient heating in the presence and absence of a minute amount of solid nitrogen in the HTS winding.

"Noise Free" NMR Magnet

A "noise free" magnet/cryocooler NMR system incorporates solid nitrogen in the system. The large heat capacity of the solid nitrogen permits "noise free" operation of an NMR system with its cryocooler idled over a period long enough for measurement. (Microphonics from the running cryocooler precludes microscopic scattering measurements.) Starting June 1, 2001, we began development of a commercially viable compact NMR magnet system based on this concept as an NIH STTR phase I project in collaboration with American Magnetics, Inc., Oak Ridge, Tennessee.

Dr. Jagadeesh S. Moodera

In condensed matter physics, in particular magnetism as well as superconductivity, our research continues to make significant contributions to both fundamental science and industrial application.

Our basic investigation emphasizes spin transport in thin film structures. Using our molecular beam epitaxy (MBE) system, our research seeks to contribute to the understanding of the spin properties of conventional materials and to unraveling the spin properties of certain novel magnetic compounds that have a high potential for technological application. Our research in these materials is further developed by companies such as IBM, HP, Motorola, Seagate, TDK and Fujitsu in this structure for application in digital storage. They have reached prototype devices: readhead sensors for over 100Gbits/sq. storage as well as nonvolatile magnetic random access memory (MRAM) elements that will potentially have a large impact on memory technology which runs into hundreds of billions of dollars. In this context, we are continuing national and international collaborative research efforts with scientists and faculty from national laboratories, US universities, the University of Paris at Orsay, the University of Eindhoven, Tohoku University, Tata Institute of Fundamental Research and the Ukrainian Academy of Sciences. Exchange of scientists and graduate students is a part of this program.

We have successfully developed a research program in the new superconductor (MgB2) science and technology for Josephson junctions that have the potential for hybrid superconducting electronics in areas such as computers, logic elements, mixers, switches and sensors. In the area of semiconductors, our continued collaboration with Hewlett-Packard Company has been valuable in searching for far future material for atomically resolved storage (> Terabytes/in2). We are exploring the materials with the appropriate properties and giving HP the fundamental information necessary for their program. In this direction we have been successful in identifying a possible candidate material from among thousands of compounds. There is ongoing collaboration with other companies such as NVE Inc., in the field of magnetism.

A new superconductor (Al/Ga) has been synthesized that is found to be highly useful as a spin detector for spin polarized tunneling. This we achieved by carefully tuning the interface structure down to a monolayer level in a bilayer thin film structure.

We have also started research programs in the fields of nanoscience for single spin transistors as well as the materials aspect for quantum computing.

Four postdoctoral scholars, two undergraduates and ten high school students have taken part in Dr. Moodera's research. One of the undergraduates did her BS thesis (won the best thesis award in DMSE) and another one

has carried out a project for his BS degree under the PI's supervision. The high school students have won several science competitions, including a regional finalist in the Intel-Westinghouse Science Competition, as well as other regional and top state level awards. (One HS student is continuing her project now at Trinity College in Ireland.)

Research resulted in several publications and invited talks at various national and international conferences, universities and laboratories.

Dr. Moodera continues his collaboration with Eindhoven Technical University (Holland) as a visiting professor. He has taken part at the national level magnetism committee policies and meeting initiatives, as well as serving in the scientific board of international meetings. He was elected as the cochairman for the upcoming Gordon Research Conference on Magnetic Nanostructures. An Electronics Journal reporter from Korea extensively interviewed the PI for a series of articles on nano electronics and molecular level electronics. A reporter from Wire Technology about digital storage and communication technology based on magnetic memory also interviewed him.

Facilities

During the past year, we have started the renovation process for the magnet cell to accommodate the 700/89 system. We are also beginning to discuss the renovations for the 900 MHz instruments.

Education and Personnel

The laboratory contributes to undergraduate education by participation in the Undergraduate Research Opportunities Program (UROP) a program that encourages and supports research-based intellectual collaborations of MIT undergraduates with Institute faculty and research staff. In addition, the laboratory has 20 full time graduate and 20 postdoctoral fellows performing research.

Future Plans

We are discussing plans to place a 3 Tesla imaging system on the first floor of NW14. The system will be used by investigators from the Department of Brain and Cognitive Science and others interested in functional magnetic resonance imaging.

In the longer term we also plan to complete construction of the second floor magnet hall, and instruments currently housed on the fourth and fifth floors will be relocated in order to create a comprehensive Center for Magnetic Resonance.

Robert G. Griffin
Director
Professor of Chemistry

Haystack Observatory

An interdisciplinary research center located in Westford, Massachusetts, some 40 miles northwest of the MIT campus, Haystack Observatory conducts astronomical studies using radio techniques, geodetic measurements using Very Long Baseline Interferometry (VLBI), and atmospheric observations using high power incoherent scatter radar. The current priority of the radio astronomy program at Haystack is the development of large arrays of telescopes that will achieve high sensitivity and resolution needed for the study of the structure of our galaxy, the early universe, and transient astronomical events. The astronomy research program is carried out under the auspices of the Northeast Radio Observatory Corporation (NEROC), a consortium of eleven educational and research institutions in the northeast. The primary objective of the geodetic research is to improve the accuracy of measurements of earth's orientation parameters by enhancing the bandwidth of the observations through innovative instrumentation development. The current goal of the atmospheric science program is to understand the impact of solar disturbances on the earth's upper atmosphere. An important component of the observatory's mission is to support the training of students by providing opportunities for them to link their education with research through the disciplines practiced at the observatory. The observatory receives financial support primarily from federal agencies including the National Science Foundation (NSF), the National Aeronautical and Space Administration (NASA), and the Department of Defense, as well as from industrial sources.

Instrumentation

The Haystack Observatory instrumentation consists of the following facilities:

- A 37-m diameter radio telescope used for astronomical observations and for radar measurements.
- An 18-m diameter radio telescope involved in VLBI measurements of the earth's rotation parameters.
- An 8-station wideband VLBI correlator used to process global geodetic and astronomical observations.
- A 2.5 MW UHF radar that utilizes two large antennas, 46m and 67m in diameter, to study the earth's upper atmosphere using incoherent backscatter techniques, augmented by passive optical telescopes.

Radio Astronomy

Haystack Observatory has successfully initiated two major new projects that have redefined the observatory's research mission in radio astronomy. The projects involve the development of radio arrays at low frequencies that will yield major enhancements in sensitivity and resolution for astronomical studies.

The first project is the Low Frequency Array (LOFAR) that will operate in the 10–240 MHz frequency range using 100 stations distributed over 400 km and connected with optical fiber. LOFAR will allow the detection of radio sources at the milli-Jansky level with arc-second resolution, and will be the first fully digital radio telescope capable of observing with multiple independent beams. The project is led at Haystack by Dr. Colin Lonsdale, and collaborators include Dr. Roger Cappallo and Dr. Sheperd Doeleman, and Professor Jacqueline Hewitt of the MIT Physics Department. The scientific projects of interest to the MIT and Haystack astronomers involve measurements of the structure of the universe at the early epoch of re-ionization and detection of astronomical transients such as gamma ray bursts through their radio emission. Under a grant received in the past year from the National Science Foundation – Information Technology Research program, the overall array configuration and system specifications have been formulated. Substantial progress has also been achieved in the development of a performance simulator that is used to assess the various design options and the effectiveness of the calibration system for the array. Specifications for the transient detector and identification of the algorithms needed to process the observations have been outlined. In addition, Haystack has initiated the design of the LOFAR antenna covering the upper frequency band (110-240 MHz).

LOFAR is a collaborative effort that includes in addition to MIT, the Naval Research Laboratory (NRL) and the Netherlands Foundation for Radio Astronomy (ASTRON). During the past year, a letter of understanding that outlined the terms of the joint development was signed by all three partners. The program management has been established and includes a science consortium board and an engineering consortium group. A kick off meeting for the project was held at Haystack in mid October 2001 and was attended by a large number of researchers from the US and European astronomical communities. This served to introduce the scientific opportunities that will be available with LOFAR for low frequency astronomy and for ionospheric and solar studies and to motivate interest and collaborations. A key long term objective is to establish a science center at Haystack to operate LOFAR and facilitate access to it by the US astronomy community. The schedule for completing the LOFAR design is early 2004. Construction would follow, leading to an initial operating capability in 2006 and a final operating system in 2008. Three candidate LOFAR sites are currently being evaluated: the southwest US, the Netherlands, and western Australia. The plan is to make a site selection by the time of the preliminary design review in early 2003.

Closely related to the LOFAR project is another large radio telescope—the Square Kilometer Array (SKA). This

array will operate at frequencies from 300 MHz to possibly 35 GHz, and will consist of about 1000 stations, thus extending LOFAR's capabilities to higher frequencies and broadening the scientific potential. Examination of various concepts to achieve the SKA goals are being pursued by a large international consortium of astronomical institutions, and key technology investigations are being initiated in various countries with the expectation that detailed design and construction would start early in the next decade. The US contributions to the SKA development are being coordinated by a US consortium that includes MIT and Haystack. Through a proposal submitted by the consortium and led by Cornell University, Haystack has been recently funded to undertake simulation studies to determine the most effective array configuration. Haystack plans to maintain a strong involvement in the SKA project and to build further on the research capabilities developed for LOFAR.

The second major new project at Haystack is the development of a multibeam array at 327 MHz for the detection of deuterium — a most sensitive indicator of the density of baryons that relates to the amount of dark matter in the universe. Detection of the deuterium line at its radio frequency has been elusive due to the inadequate sensitivity of available telescopes. Haystack's proposed approach is through the design of a sensitive digital receiver for a 32-station array of dipole elements with dual polarization that will be constructed at the observatory in Westford. The project is led by Dr. Alan Rogers and is funded by the NSF Major Research Instrumentation program, with cost-sharing support from TruePosition, Inc., which supports research at Haystack on the radio location of E911 calls from cellular phones. Prototyping of the antenna and receiver have progressed well during the past year, and a major effort has been expended on characterizing the radio frequency interference environment at 327 MHz around the MIT site in Westford. Following tests of the prototype system, construction is expected to start in 2003 and astronomical operations to detect the deuterium line will occur in 2004.

Other astronomical research work by Haystack staff continues through the conduct of VLBI experiments at millimeter wavelengths using a global array of twelve radio telescopes. The most significant scientific result that has emerged from this research in the past year has been the first detection of interferometric fringes on a radio source at 129 GHz. The experiment was led by Dr. Shep Doeleman of Haystack using two millimeter-wave radio telescopes in Arizona—one on Kitt Peak and the other on Mt. Graham. The IRAM telescope in Spain also participated through collaboration with the Max Planck Institute in Bonn, and the resulting fringes on this long baseline set a new record for angular resolution at ~50 micro arcseconds. A map of the silicon monoxide maser emission towards the evolved star VYCMa revealed features that suggest the presence of a stellar disk with a gas outflow resulting in a nebula which has been known to exist in this star from optical observations. It is Haystack's intent to concentrate in the future on VLBI observations at wavelengths less than 3 millimeters, since these offer both technical challenges and exciting potential for scientific discovery. In order to support these new studies, a collaboration with the University of Arizona has been established, and a proposal has been submitted jointly to the NSF. With this new emphasis, routine VLBI operations at 3 millimeter wavelength is being transferred in 2003 to the National Radio Astronomy Observatory in Socorro, New Mexico, as part of operations of the Very Long Baseline Array.

Instrumentation Development

Haystack's instrumentation development program is focused on high data rate recording and on efficient transfer of wideband data from telescopes participating in geodetic and astronomical VLBI experiments to the central processors or "correlators." Under the leadership of Dr. Alan Whitney, the Mark 5 data system is being designed to operate at a recording rate of 1 Gbit/sec, utilizing commercial off the shelf components based on magnetic disks. The Mark 5 will replace the aging tape recorders that are expensive to maintain and have limited bandwidth and growth capability. The Haystack development work is supported by funding partners from the national and international astronomy and geodesy communities, and involves an industrial firm, Conduant Corporation of Colorado, which is supporting Haystack's project. The past year's work has resulted in the completion of prototype systems that have been placed at radio telescopes in Westford, Hawaii, and Germany for initial tests. Successful completion of these tests led to further production of beta units that are now being distributed to all participating partners in order to acquire operational experience with these new systems. The Mark 5 data systems will then be upgraded based on the feedback received, and the design will be transferred to industry for full implementation worldwide.

As part of the Mark 5 system development, the necessary interfaces for radio telescopes are being designed so that data can be eventually transferred using high speed wideband communication links. With the rapid expansion of fiber optic links across the US, Europe and Japan, real time transmission of VLBI data from the radio telescopes to the correlator has become feasible. The advantages of real time data transmission include the further expansion of bandwidth beyond that allowed through data recording, as well as the ability to test experimental setups in the field through prompt verification of initial data acquisition and reduce processing delays. Dr. Whitney's team has initiated tests of real time VLBI data transmission, dubbed 'e-VLBI', using the new fiber optic link installed by Lincoln

Laboratory to connect Haystack with the laboratory in Lexington and the MIT campus, as well as DARPA's Bossnet system that connects the fiber to the Washington DC area. With seed support from DARPA and NASA, data transmission at near 1 Gbit/s was successfully tested during the past year, and now the Observatory's 60-m telescope in Westford is being linked through the fiber network to a 10-m telescope at Goddard Space Flight Center in Maryland. Data from both telescopes will be transmitted to the Haystack Mark 4 correlator to demonstrate the capabilities and advantages of real-time processing.

A workshop on connecting the global array of radio telescopes with high speed networks was convened at Haystack in April 2002 and was attended by about 80 astronomers and network experts from the national and international community in the US, Europe and Japan. Much enthusiasm was expressed for linking the telescopes through wideband fibers and for solving the "last mile" problem of connecting telescopes that are generally located away from population centers to avoid frequency interference. Plans for insuring compatibility of interface equipment amongst the telescopes were also formulated. Motivated by this enthusiasm, Haystack Observatory prepared and submitted a proposal to the NSF Division of Computer and Information Sciences Directorate, in collaboration with the MIT Laboratory for Computer Sciences (LCS) and the Lincoln Laboratory, to develop and test the necessary protocols for sharing the available commercial bandwidth on internet fibers. The project led by Dr. Whitney of Haystack and Dr. John Wroclawski of LCS has been approved and will form the focus of our research work in this area for the next few years while the fibers are being installed at various telescopes worldwide in order to connect them to the global grid.

Finally, in a project led by Dr. Alan Rogers and supported by TruePosition, Inc., Haystack has recently supported a critical field test of a network system that locates E911 calls from cellular phones, using VLBI time delay measurement techniques. The test, conducted in Houston using Cingular's cellular network, successfully demonstrated the accuracy of the system to locate such calls well within the specifications set by the FCC. This success will now allow full implementation of the location system on Cingular's network. Current plans call for further research on future digital cellular phone systems and on the use of angle of arrival measurements to support radio location in rural areas. Haystack Observatory plans to continue its technical consulting role for TruePosition with emphasis on the challenging new digital systems to be deployed in the future.

Atmospheric Science

The primary focus of the atmospheric science research at Haystack Observatory continues to be placed on the study of the effects of solar disturbances on the Earth's upper atmosphere and ionosphere. The disturbances cause large geomagnetic storms that produce severe gradients in ionospheric density and scintillations in radio signals caused by small scale structures and turbulence in the upper atmosphere. Such effects of "space weather" have a deleterious impact on communication satellites and on navigation systems that rely on the Global Positioning System (GPS). The observatory's atmospheric sciences group led by Dr. John Foster has studied space weather effects on Earth's middle latitudes using both the Millstone Hill radar and ground based GPS receivers, in combination with NASA's and DoD's fleet of satellites stationed in the solar wind and in earth's magnetosphere. In collaboration with scientists at Rice University, Lincoln Laboratory, and the Air Force Research Laboratory, the studies have revealed that during geomagnetic storms, enhanced electron densities result from the erosion of the outer plasmasphere by penetration electric fields. Plumes of enhanced density in earth's ionosphere as seen with the GPS network and the observatory's incoherent scatter radar at sub-auroral latitudes map directly into the plasmaspheric tails that are imaged by satellites such as NASA's IMAGE spacecraft. Such a coupling between the magnetosphere and ionosphere serves to clarify the relationship between these two regions and the role of the plasmaspheric tails that develop during magnetic storms in modifying earth's ionosphere.

Another major area of research in the atmospheric sciences group involves the study of perturbations due to geomagnetic storms on Earth's neutral atmosphere at altitudes above 80 km—in the mesosphere and thermosphere layers. The study uses a combination of data from the global network of incoherent scatter radars including the observatory's Millstone Hill radar and from NASA's TIMED satellite that was successfully launched in December 2001. Led by Dr. Joseph Salah and staff in the atmospheric sciences group, in collaboration with an international team of scientists, the project has successfully captured the effects of a major geomagnetic storm that occurred on 17-19 April 2002. The storm resulted in large enhancements of neutral winds up to 500 m/s at 120 km and electric fields as large as 100 mV/m in the ionosphere, compared to 50 m/s and 1-2 mV/m during quiet conditions. Detailed analysis of the radar and satellite data is now proceeding, and several workshops have been organized to interpret the measurements for one of the best-documented storms to be observed in a coordinated "alert mode" campaign using a vast array of satellites and ground-based radars.

Statistical models of the earth's ionosphere are being developed by Dr. John Holt and collaborators using the large database of ionospheric observations collected with the Millstone Hill incoherent scatter radar since 1961. Emphasis in this modeling effort is on delineating the effects of solar flux, seasonal, and geomagnetic index

dependencies, and representing the daily variations of electron density, temperature, plasma and neutral motions at various altitudes with analytical expressions. Because of the large data set, such variations can now be reliably determined and long-term trends can be derived from the observations. The models have been produced in terms of "movies" that provide an excellent visualization of the variations, and these will be used in verifying the results obtained from theoretical models based on first principles such as the solution of the coupled momentum, energy and continuity equations. The statistical models are made freely available to the community at large through the web, and can be exercised with a user friendly method to specify the entry parameters. The next phase of the project is to expand the model to more global coverage by including radar observations from other locations.

Educational Programs

Opportunities for education and research in radio astronomy at the undergraduate level using the MIT facilities at Haystack continue to be provided and expanded successfully under the leadership of Dr. Preethi Pratap, the observatory's educational officer. The primary component of the educational program has been the development of a small radio telescope (SRT) kit that can be assembled and used by students for observations. The kit, consisting of a steerable 2-m antenna and a 1.4 GHz receiver, has now been successfully commercialized and a total of 70 SRTs have so far been distributed to various colleges and universities in the United States and overseas. The SRT has been upgraded with a digital receiver that allows more sensitive observations to be made, a noise source calibrator has been added, and the feasibility of radio interferometry using two SRTs has been demonstrated during the past year. The educational research projects using the SRT, such as monitoring the solar flux and detecting flares, continue to be developed and placed on the observatory's educational web site so that they can be shared widely with the community. Evaluation of the effectiveness of the SRT as a research learning tool has indicated that many of the colleges have successfully integrated the SRT and its projects into their undergraduate courses and laboratory activities, thus providing an important hands-on element for introducing research and observational techniques to students. Our future plans involve the connection of two or more SRTs in the field to teach the principles of radio interferometry and allow high-resolution measurements of features on the sun.

In addition, the observatory's 37-m telescope continues to be used by students for research projects that require higher sensitivity than that of the SRT and require observations at frequencies above 1.4 GHz. A total of 220 students from 23 colleges within the NEROC consortium and elsewhere have utilized the observatory's 37-m telescope during the past year, by either visiting Haystack or controlling the telescope remotely through the internet. Projects included the search for methanol masers in the Milky Way galaxy which are signposts for regions of star formation, mapping the structure of gas clouds using the ammonia line, and monitoring of emission from water vapor masers. To help introduce faculty from small colleges to radio astronomy techniques and to the educational facilities at Haystack, a short course under the NSF Chautauqua series is offered annually at the observatory and is attended by 15-20 faculty members. Training on the use of the 37-m telescope and the SRT kit are included in this course, and has been found to be an effective way to disseminate the information widely.

Haystack's Research Experiences for Undergraduates (REU) program has been extended by the NSF for another five years. Its purpose is to provide summer research internships for undergraduate students, thus strengthening their education through research. The students are recruited nationally and are mentored by MIT staff at Haystack as they work on various observatory projects. Outreach to pre-college teachers has continued through the Research Experiences for Teachers (RET) program, which provides internships to local area science teachers. The teachers develop lesson plans based on what they learn at Haystack and use them in their science classes.

Joseph E. Salah
Director

More information about the Haystack Observatory's research and education programs can be found on the web at http://www.haystack.mit.edu/.

International Scholars Office

The International Scholars Office (ISO) enables MIT faculty and staff to bring international researchers and professors to campus for a variety of purposes. The ISO advises on immigration matters, issues visa documents, and provides guidance, workshops, and literature on a wide range of issues relevant to the international scholar population. Weekly orientation sessions are held for incoming scholars and family members.

The ISO also engages in advocacy efforts to protect international educational exchange, prevent burdensome regulations, and clarify and improve related regulations and procedures.

MIT's International Scholar Population

The ISO served a total of 1,641 international scholars who were affiliated with MIT during the period from July 1, 2001 to June 30, 2002, down from 1,679 last year. The ISO also served the accompanying family members of scholars and other members of the MIT community. According to HRIS data, over 60 percent of MIT's postdoctoral associates and fellows are foreign, as are over 50 percent of "visiting" appointees. During the past year, international scholars came to MIT from 82 countries, with the highest number coming from the People's Republic of China (181), Japan (166), Germany (158), Republic of Korea (120), France (88), Canada (86), India (85), Italy (79), the United Kingdom (69), Israel (46), and Russia (46). MIT ranks fifth nationally among institutions hosting the most foreign scholars.

In the past year, the ISO worked closely with administrators in 67 departments, laboratories, and centers, and prepared the appropriate visa documents or petitions for incoming and continuing scholars and their families. The areas hosting the largest number of scholars are the following, in descending order: Chemistry, Biology, Sloan School of Management, Research Laboratory of Electronics, Earth Atmospheric and Planetary Sciences, Mechanical Engineering, Chemical Engineering, Department of Materials Science and Engineering, Laboratory for Nuclear Science, and Center for Learning and Memory.

The majority of MIT's international scholars are sponsored on MIT's J-1 exchange visitor program. There were 1,005 scholars under MIT's J-1 program sponsorship during the 2000-2001 period, and an additional 78 here through other J sponsors. There were also 246 scholars who were sponsored by MIT on the H-1B visa, reflecting a steady increase over 225 H-1B scholars in 2000-2001 and 185 in 1999-2000. There were 10 international scholars on campus this year whose O-1 visas were sponsored by MIT. The rest of the scholar population had other sponsors or nonimmigrant categories. (Note that some of the 1641 scholars held more than one visa status over the course of the reporting period.) The ISO also submitted 18 permanent-residence petitions to the Immigration and Naturalization Service (INS) on behalf of MIT faculty members and upper-level researchers.

The impact of September 11 pervaded MIT's international scholar population. Fear of anti-immigrant reprisals, travel restrictions, fear of discrimination, detention or deportation, and rumors were common in the international community. The MIT upper administration showed tremendous support for this population and for the ISO. The reaction of the administration was key in reducing fear, offering assistance and restating the Institute's intolerance of racial and ethnic harassment or discrimination of any kind. The strong reassurance of the international community was evidence of MIT's respect for and commitment to diversity and multiculturalism. In the days and weeks following the terrorist attacks, the arrivals of new and returning international scholars were delayed and scholars were stranded abroad as more than 50 US embassies and consulates closed and planes were grounded. With the assistance of the ISO, most anticipated visitors were eventually able to secure visas and enter the United States to begin their MIT teaching and research. Some scholars had already arrived for the fall when the terrorist attacks occurred on September 11, 2001. ISO quarterly reports do not show a decline in scholar numbers for fall 2001 compared to fall of 2000. However, statistical reports from January to June 2002 show a decline of approximately two percent compared with the same period the previous year.

Primary Activities and Accomplishments

The events of September 11 focused the attention of Congress and government agencies on the processes through which foreign nationals obtain visas, are inspected at ports of entry and are monitored during their stays in the United States The director of the ISO and other members of the MIT administration assembled quickly to develop a protocol for dealing with inquiries from law enforcement, FBI, the Immigration Service or other agencies regarding members of the MIT community. An unprecedented amount of legislation was proposed and implemented, significantly affecting the international population. These include the USA PATRIOT Act, the Enhanced Border Security and Visa Entry Reform Act, and the Homeland Security Presidential Directives. As a result, consular procedures, immigration forms, government agency and border crossing procedures, and immigration regulations changed. Department of State security clearance checks were implemented and enforced. The ISO kept abreast of these changes, advising scholars and their families on their effects. ISO advocated against a moratorium on the issuance of visas to international students and scholars, distributed periodic updated advisories to international

scholars and MIT departments, labs and centers on visa delays, security clearances, travel and maintaining valid immigration status. ISO publications and website were also updated with each new procedural change. Throughout this period, Jack Crowley, Vice President for Federal Relations, informed the ISO of developments anticipated to have an effect on the international population at MIT.

The Student and Exchange Visitor Information System (SEVIS), an electronic system to track the visa issuance, arrival and presence of international students and scholars in the United States has been fast-tracked. Institutions are mandated to implement the system by January 2003, though the section most relevant to exchange visitors has not yet been released by the INS. The ISO director and assistant director have examined the released version of the "student" component of the system and the relevant regulations from INS. They also attended meetings where the provisions of the anticipated scholar regulations were discussed and they are preparing the ISO for compliance.

The director and assistant director continued to serve on the NAFSA Employment Based Working Group, providing information for use in government advocacy by NAFSA: Association of International Educators. Dana Bresee Keeth concluded her term on NAFSA's national Committee on Immigration Policy and Practice, but remained active as chair of the Working Group on Exchange Visitor Issues. Dana and Penny Rosser participated in the Ivy League annual meeting in Chicago. They, as well as advisors Mary Schrot and Sharon Ralston, participated in the Boston Area Responsible Officers group meetings. The Department of Labor published a lengthy proposed rule affecting the H-1B visa category and the process of permanent labor certification, to which the ISO will respond in detail.

In addition to advising, preparing immigration documents, running a weekly orientation program, and providing extensive written and web-based information, the ISO sponsored an annual tax workshop, and sponsored the annual fall International Open House for newcomers in partnership with the International Students Office. The ISO also held workshops for new administrators in departments, laboratories and centers regarding visa processing.

Personnel

In spring of 2002, ISO bid farewell to Dana Bresee Keeth, who left her position as director to spend more time with her family. However, ISO is pleased to report that we will benefit from her expertise as a part-time advisor for International Scholars on advocacy issues. Penny Rosser was appointed acting director and, after a national search, was appointed director of the ISO effective July 1, 2002. Michael Welch left his position as administrative assistant in December 2001, and the ISO was fortunate to hire Amanda Doran as our newest staff member. Sharon Ralston and Mary Schrot continue in their positions as advisors, providing thoughtful advising, programming and invaluable assistance to the international scholar population and their families.

Penny Rosser
Director

More information about the International Scholars Office may be found in the ISO annual report on the web at http://web.mit.edu/scholars/.

Center for Materials Science and Engineering

The Center for Materials Science and Engineering (CMSE), an interdepartmental center at MIT, continues to be an innovative and dynamic program in interdisciplinary materials research and education. Funded since 1994, CMSE is one of the largest of a nation-wide network of twenty-eight Materials Research Science and Engineering Centers (MRSEC) sponsored by the National Science Foundation (NSF). MIT has a large and diverse materials community with over 110 faculty in 12 departments in the schools of science and engineering. CMSE plays a central role in providing focus and critical infrastructure to materials research and educational activities by creating a dynamic research environment in which interdisciplinary collaborations and innovation are encouraged and the best research is funded. To this end, we have adopted the following strategic goals:

- Establish and maintain world class research through IRGs and seeds
- Invest in young investigators using seed and initiative funding
- Connect fundamental science and engineering to technology, and foster the transfer of CMSE-developed technology to industry
- Educate and develop students and postdoctoral associates in team-based interdisciplinary materials research
- Provide innovative educational outreach programs for students and teachers from pre-high school to the graduate level
- Establish and maintain unique, state of the art facilities to support IRGs and the greater materials community
- Maintain proactive and effective management and a flexible and lean organization capable of responding quickly to emerging needs

Much of the research at MIT addresses intermediate-term engineering problems, often with the participation and support of industry. However, the longer-range problems, especially those that require a multi-investigator approach, are often overlooked. In this environment CMSE has a special mission: to foster collaborative interdisciplinary research and education in the fundamental science of materials and in the engineering of materials for long-range applications that will meet the needs of society. To accomplish this, CMSE promotes collaboration among MIT faculty and between MIT researchers and the researchers of other universities, industry, and government and nonprofit laboratories.

Collaborative research is encouraged through several mechanisms: interdisciplinary research groups (IRGs), shared experimental facilities (SEFs), and outreach programs. The IRGs, described below, are composed of MIT faculty who, with their students and postdoctoral associates, investigate fundamental scientific questions and pathways to reach significant technological goals that can only be properly explored in a collaborative, multidisciplinary mode. These problems are too large in scope to be addressed by individual faculty members and their students. Collaboration is essential for materials related science and engineering, even for individual investigators, because such research requires very sophisticated equipment. CMSE provides a mechanism for the purchase and supervision of such equipment in its SEFs. The equipment is made available to the members of the IRGs, individual MIT investigators, and researchers from other university, industrial, government, and nonprofit laboratories.

CMSE also provides seed and initiative funds. While preference is given to young faculty, CMSE uses seed and initiative funds to support research that has the potential of redefining the direction of an existing IRG or leading to the creation of a completely new IRG. Seed funding provides CMSE with the flexibility necessary to initiate high-risk research.

Administration, Management and Research

The director of CMSE reports to the vice president for research and associate provost, who reports jointly to the provost and the chancellor, the chief academic officers of MIT. There is an external advisory committee as well as internal committees, the most important of which is the Internal Advisory Committee (IAC) that advises the director about major decisions. The IAC is composed of the IRG leaders, and the faculty education and shared experimental facilities leaders. The center is administered and staffed by an assistant director/administrative officer, a SEF technical manager, a senior program administrator, a financial administrator, a facilities manager, an administrative staff assistant and an administrative assistant.

Much of this past year was spent on proposal preparation and submission. Not only did we submit a non-competing continuation for our current funding but we also submitted a competitive renewal for the MRSEC contract that funds the entire center. Our administrative staff has stabilized over the past year with everyone becoming more proficient at their jobs. Major renovation of the air handler in Building 13 was completed over the past year.

Interdisciplinary Research Groups

Microphotonic Materials and Structures

In the past 50 years, semiconductor technology has come to play a vital role in almost every aspect of our daily lives. In

the next 50 years, our technology may be just as thoroughly revolutionized by the replacement of electrons with photons (i.e. light) as the carrier of information. Photons have several advantages over electrons, including greater speed, greater information carrying ability, and greater energy efficiency. The key to achieving this advance, and the principal goal of this IRG, is the development of an exciting new class of materials, called photonic crystals, which will allow control of the confinement and propagation of light in very small dimensions, thereby enabling the design and integration of a large number and variety of optical microdevices on a single chip.

Participating faculty and departmental affiliations: H. A. Haus, E. P. Ippen, L. A. Kolodziejski, and H. I. Smith (Electrical Engineering and Computer Science); L. C. Kimerling (Materials Science and Engineering); and J. D. Joannopoulos (Physics).

Nanostructured Polymers

This group seeks to gain a fundamental understanding of the factors that control the way complex, electronically active polymer systems organize at the molecular level. The knowledge obtained from this work is expected to make it possible to control and significantly enhance the performance of electronic, magnetic, and optical devices based on these materials. The objective of this IRG is to develop the chemistry and processing needed to control the composition and spatial arrangement of constituents of multicomponent polymeric materials with novel electrical and optical properties.

Participating faculty and departmental affiliations: R. E. Cohen (Chemical Engineering); M. Bawendi, R. R. Schrock, and R. J. Silbey (Chemistry); and A. Mayes, M. F. Rubner, and E. L. Thomas (Materials Science and Engineering).

Electronic Transport in Mesoscopic Semiconductor Structures

The steady decrease in the size of semiconductor structures that has brought about the information age has also made it possible to study new electronic transport phenomena. Whereas classical transport theory describes the behavior of electrons in macroscopic systems (like conventional transistors), and the quantum mechanics of microscopic systems (like atoms) is reasonably well understood, the intermediate regime, termed mesoscopic, continues to reveal surprises and opportunities for novel electronic devices. In particular, whereas some mesoscopic effects are subtle, those resulting from confining electrons to reduced dimensions (in quantum dots, for example) are very dramatic. It is the goal of this IRG to understand the fundamental physical principles governing transport through and between semiconductor nanostructures created by both self-assembly and lithography techniques.

Participating faculty and departmental affiliations: R. Ashoori, M. A. Kastner, P. Lee, L. Levitov, and X.-G. Wen (Physics); M. G. Bawendi (Chemistry); and E. A. Fitzgerald (Materials Science and Engineering).

Microstructure and Mechanical Performance of Polymeric Materials

It is widely recognized by polymeric material producers that the key to polymer penetration into new product markets is through the optimization of industrial polymers on the market today. Thermoplastics offer major advantages in load bearing applications because they are inexpensive, light weight, easily processed into desired form, and recyclable. However, their mechanical properties limit their applicability. Recent advances in the ability to study material microstructure and deformation at multiple length scales have created tremendous new opportunities for developing methodologies for truly designing polymeric material systems. The goal of this IRG is to provide a mechanistic basis for tailoring polymer microstructure in order to achieve dramatic improvements in multiple mechanical properties by exploring and exploiting connections among microstructure, mechanisms and mechanical performance. This IRG will be phased out over the coming year in order to make way for the Lithium Battery initiative to take its place.

Participating faculty and departmental affiliations: A. S. Argon, M. C. Boyce, and D. M. Parks (Mechanical Engineering); and R. E. Cohen, K. K. Gleason, and G. C. Rutledge (Chemical Engineering).

Doped Mott Insulators

Several of the most interesting phenomena discovered in materials science in the past decade occur in a class of substances called Mott insulators. For example, high critical temperature (Tc) superconductivity occurs when certain copper oxide Mott insulators are doped to make them conducting. The effect of doping on the electronic and magnetic properties of Mott insulators is one of the great unsolved problems in condensed matter physics. The members of this IRG believe that the understanding of high Tc superconductivity, in particular, will require the solution of this larger problem. Apart from the intrinsic scientific interest, a deeper understanding of doped Mott insulators will pave the way for the exploitation and control of this technologically interesting class of materials

Participating faculty and departmental affiliations: M. A. Kastner, T. Imai, and P. A. Lee (Physics); F. C. Chou (Research Scientist, CMSE); and R. J. Cava (Chemistry, Princeton University). Due to a reduction in NSF funding this IRG will be phased out in 2002-2003.

During the past year, we supported eight seeds and one initiative on lithium batteries. Our initiative on Heteropolymers and Gels was phased out due to the death

of the initiative leader, Professor Tanaka. Five of our seed investigators were junior faculty and a number of them will be promoted to IRG status soon, including one that has been made a full IRG member this past year; Professor Ross was made a full member of IRG-II. In the coming year, two of our existing seed investigators will be promoted to IRG status: Professors Nelson and Fink will be moved into IRG-I. Our initiative and seed projects funded during the 2001–2002 year are listed below.

Initiative Project

Lithium Batteries (G. Ceder, D. Sadoway, A. Mayes, Y.-M. Chiang, R. Smith). Rechargeable Li batteries with a solid polymer electrolyte (SPE) could be the ultimate power-storage device due to their high potential energy density and low cost. Li-SPE imposes no limitations on the shape of the battery and is inexpensive to process, in contrast to current battery technology based on liquid electrolytes. Development is impeded by materials problems that are difficult because of the interaction between electronic, chemical and mechanical phenomena. The members of this initiative have expertise in electrochemistry polymer synthesis and characterization, oxide synthesis and first-principles electronic structure calculations. The objective is to develop the basic science behind rechargeable Li batteries, and use it to develop superior materials for this application. Initially, the focus will be on the development of a block copolymer solid electrolyte (BCE), and a high energy density, low cost, intercalation oxide for the cathode. With block copolymers, a microstructure can be formed that is locally liquid-like (allowing high ionic conductivity), but globally solid-like (giving the material mechanical rigidity). To design a novel cathode intercalation oxide, the group will use first principles calculations to determine the factors that influence the phase stability of the intercalation oxide. This project will be turned into an IRG for the next funding period.

Seed Projects

- Phonon-Polaritonic Bandgap Crystals (K. Nelson) IRG-I associated seed
- Tuning the Emission Wavelength and Improving the Efficiency of Organic LEDs through Nanostructuring of Materials (V. Bulovic)
- Novel Fibers for Efficient Transmission of Electromagnetic Waves (Y. Fink) IRG-I associated seed
- Chemical Control of the Spatial Position of Quantum Dots in Thin Film Composites (K. Jensen)
- The Ideal Kagomé Lattice: Synthesis and Magnetism of Pure and Single-Crystalline Jarosite-Type Compounds (D. Nocera) IRG-V associated seed
- Actin: Paradigm for Active Polymeric Materials (A. van Oudenaarden)

Collaboration with Industry and Other Sectors

MIT was chartered with a mission of collaboration with industry and has therefore established a variety of mechanisms to encourage this. CMSE works in concert with a number of MIT industrial programs and centers to facilitate the transfer of the fundamental knowledge generated within the program to industry. MIT's Materials Processing Center (MPC) and Industrial Liaison Program (ILP), for example, work cooperatively to connect industry to the research carried out within the MRSEC program. The MPC, in collaboration with the ILP, will frequently invite members from industry (the ILP has 185 member companies) to come to MIT to review recent developments by CMSE researchers. This is done on an individual company basis or in the form of workshops and colloquia that are attended by representatives from many different companies.

Our IRG researchers have ongoing industrial collaborations and interactions with many industrial researchers, including collaborations with Advanced Cerametrics, AmberWave Systems Corporation, Analog Devices, Bayer, Bell Labs , Bluefin Robotics, CibaVision, Coatue Corporation, Confluent Photonics, Continuum Control Corporation, Draper Labs, Dupont, Eastman Chemical, Energizer, Exxon/Mobil, Ford Corporation, Hewlett Packard, Honeywell, Huber Corporation, IBM, Intel Corporation, Intronics, Inc., Lord Foundation & Corporation, Lucent Technologies, LumiLEDs, Mars Corporation, Motorola, National Semiconductors, Nomadics, Inc., Novellus Systems, NTT, Pall Corporation, Photran, Inc., Pratt & Whitney, Quantum Dot Corporation, Rockwell, Seagate, Talking Lights, TDK-USA, Union Minière, Universal Display Corporation, and Valence Technologies.

The SEFs are a critical feature of CMSE's collaborations with non-MIT personnel. The facilities are made available to any researcher from a nonprofit institution and to industrial researchers when equivalent facilities are not available commercially. Several of the IRGs participate in direct research collaboration with industry and other sectors. This is important for exchange of knowledge and the education of graduate students, for it provides them with direct experience of industrial research. CMSE currently maintains the following SEFs: Electron Microscopy, Analytical Crystal Growth, X-ray Scattering and Neutron Scattering.

Education, Human Resources, Outreach, and Affirmative Action

The education, human resources, and outreach effort of the center has been expanded significantly during the past year. CMSE offers a range of programs for students from pre-college to the graduate level, as well as to middle and high school science teachers. This portfolio of programs is managed by a full time education officer, who works closely with a faculty education program leader (S. Leeb), the center director and MRSEC faculty to create and maintain outreach activities. We regularly review our educational activities to insure their effectiveness. During the past year, a new educational committee was formed. Its membership is comprised of personnel from outside of the MRSEC program who are actively involved in educational outreach at MIT. The role of the committee is to consult on the direction of CMSE's educational programs and to coordinate the center's programs with other outreach efforts on campus. The committee is considering opportunities for further collaboration between CMSE and the other MIT units involved. Besides involvement in the formal education and outreach activities outlined below, our MRSEC-supported faculty and graduate students frequently engage in various outreach activities with local schools, religious and minority organizations, and professional organizations. A recent survey, for example, revealed that over the past year, MRSEC-supported faculty worked with ten different outside organizations on various educational outreach activities, with contributions totaling more than 400 hours.

Pre-College Education

Science and Engineering Program for Middle School Students

CMSE continues to operate a science and engineering program that targets seventh and eighth grade students who attend two nearby Cambridge public schools. The objectives of the program are to familiarize the students with the field of materials science and engineering, demonstrate that science and engineering are fun and interesting, introduce students to a college environment, and expose them to some of the exciting resources at MIT. The program includes a full summer week of hands on and inquiry based activities in science and engineering for each school, plus several after-school sessions during the academic year. Because the students are on campus from 8:00am–3:00pm each day, meals are provided to participants. The Center also provides bus transportation between the schools and MIT.

Participants in the 2001 program included a total of 11 students from the Morse and Fletcher Elementary Schools. Of these, four were girls and seven were boys. Eight of the students were from underrepresented minority groups. The science teachers from the two schools attended with their students. As the teachers know their students personally, they were responsible, with the assistance of other school staff, for selecting the participants. Program activities were designed and presented by four MIT faculty members, seven staff members, a graduate student, a postdoctoral associate, and three undergraduates.

Activity periods were 90 minutes long, and included a wide range of topics. The 2001 program involved glassblowing, metal casting, polymer chemistry demonstrations, building an electric circuit that simulates a traffic light, building a simple motor, computer design and programming of mini-robots, and designing and fabricating a machine to shoot a marble through a hoop. The program concluded with a "shoot the hoop" design competition, which was attended by the families of the program participants. The activities offered are continually evaluated by Professor Leeb, the two teachers, and the faculty, staff, and MIT students who work on the program. New projects are developed regularly, and the faculty and staff who lead activities vary from year to year.

MIT's Edgerton Center, the MIT Museum, and the Departments of Chemistry, Physics, EECS, and DMSE have all collaborated with CMSE in conducting projects with the middle school students while they were on campus. The Edgerton Center and CMSE share an undergraduate student who develops, refines and presents educational outreach projects during the summer. CMSE activities are incorporated into the Edgerton Center's outreach offerings, just as the Edgerton Center offers activities it develops to participants in CMSE's program.

Materials Research Experience for Teachers (MRET)

During the past three summers, the center has grown a very successful Materials Research Experience for Teachers (MRET) program. High school and middle school teachers spend seven weeks in the summer performing research with CMSE faculty and students. The number of participants (eight) more than doubled during the past year, and now includes teachers who participate for two successive summers. Applicants to the program are solicited from the Cambridge School Department and from alumni of the Science and Engineering Program for Teachers (totaling about 500 members). They provide information on their teaching experience, subjects taught, and research interests. Once on campus, Professors Rubner and Leeb work with the teachers to match them up with appropriate research projects.

The MRET program has been enhanced by two additional features over the past year. First, each Friday afternoon during the summer was dedicated to an introduction to the operation, capabilities, and applications of the state of the art equipment in CMSE's Shared Experimental Facilities. The second exciting new component of the program is a

deliberate focus on having the teachers design lesson plans, lab kits, and other tools to transfer their research experience at MIT to their students in the classroom. A further goal is to share these materials with other educators to broaden the impact beyond direct MRET participants. For instance, on November 9th, two RET participants presented a high school module they developed on fabricating light emitting thin film devices to teachers at the annual convention of the Massachusetts Association of Science Teachers. A companion paper is being prepared for publication in a science education journal. Other, informal, partnerships between the teachers and CMSE have been formed. While on campus, teachers have identified opportunities for their students at MIT and have involved CMSE research group members in school visits and science fairs.

During the summer of 2001, five new teachers spent seven weeks immersed in research on campus. Michael Doherty, a high school physics teacher in Andover, MA, and Lea Lewis-Santos, a middle school teacher from Cambridge, MA, worked on magnetic actuators in Professor Leeb's lab. Daniel Menelly, an eighth-grade teacher from the United Nations International School, joined Professor Rubner's group studying light-emitting thin-films. He also worked informally with Professor Bulovic on his research project. Rebekah Ravgiala, a high school biology and physics teacher in Merrimack, New Hampshire, collaborated with an REU student and a graduate student in the labs of Professors Cohen and Hammond to work on the polyelectrolyte multilayer assembly of bio-active polymers. The fifth teacher, Bill McDonald, a middle school teacher in Cambridge, Massachusetts, studied baroplastic polymers with Professor Mayes' research group. Three former MRET participants, Hannah Sevian, Sean Müller, and Raymond Sleeper, returned this past summer to develop tools for the transfer of their research experience to the classroom.

CMSE extended its outreach to K–12 science teachers in another new effort this year. In collaboration with MIT's Council on Primary and Secondary Education, CMSE faculty presented their current research to 75 participants in the Science and Engineering Program for Teachers, a week long, intensive enrichment program for teachers held on campus in June. In addition, the center sponsored a full day workshop for about 30 members of the Network of Educators in Science and Technology. This day focused on CMSE research, with an emphasis on how teachers can utilize this cutting edge material to support and enhance their classroom curriculum.

Undergraduate Education

UROP

MIT's Undergraduate Research Opportunities Program (UROP) provides an ideal mechanism for formalizing undergraduate involvement in CMSE research, and the Center intends to continue to offer this experience to approximately 15 undergraduates in the coming year. Students work a maximum of ten hours per week during the fall and spring semesters, and forty hours per week during January and the summer months. Students are required to submit written proposals to Professor Leeb for review prior to each semester of UROP research. CMSE faculty advise the students about the technical content of these proposals and oversee the conduct of the research. At the end of each term, UROP students write reports outlining the results of their work and evaluating their experiences. During the past year, 17 students participated in the UROP program with support from CMSE. Eleven of them were men, six were women, and two were members of underrepresented minority groups. Three students took advantage of the interdisciplinary nature of CMSE's research program to work with faculty members outside of their own academic departments. In addition to the students funded by CMSE, the center benefited from the work of 27 undergraduates who were supported by other funds or who received academic credit for their MRSEC research. CMSE's UROP program provides unique opportunities for undergraduates to work closely with research teams of faculty, graduate students and postdoctoral researchers on materials science and engineering projects.

Summer Research Internship Program

In collaboration with MIT's Materials Processing Center, CMSE operates a Summer Research Internship Program (REU). The two centers intend to continue this collaboration for the summer of 2002. The goal of the program is to offer materials research experiences to undergraduates. It also offers students considering graduate study a chance to test their interest by participating in a research team of faculty, research staff, and graduate students. An additional objective is to encourage outstanding students to pursue an advanced degree and career in science or engineering.

In 2001, the internship program essentially doubled in size. The program attracts approximately 150 applicants a year. In the past we have accepted 10 students each year. This year we accepted 20, 17 of whom elected to participate. Interns are selected on the basis of their academic performance, statement of interest, and faculty references. The program is open to US citizens and permanent residents who will be juniors or seniors the following fall. Applications are reviewed by a committee consisting of staff members from both centers, with final review by the directors. The 17 participants in the program during the summer of 2001 included six women and twelve men.

The program begins with a three-day symposium featuring faculty presentations on their research and tours of their labs. Twenty-four faculty participated last summer. After hearing about current research options, the interns met with Professor Rubner and Dr. George Kenney of the

MPC to select appropriate projects for the summer. The students are paid stipends and work full-time for ten weeks. Most of them live in a dormitory on campus. Weekly meetings are devoted to research discussions and informal seminars with guest speakers on topics such as the graduate school admissions process, research funding, and intellectual property. This summer, for the first time, the program concluded with a poster session rather than oral presentations. This was very effective and extremely well attended, so we intend to maintain this format. An evaluation survey was completed by each intern before leaving in August. Overall, they were happy with their experiences in the program.

Graduate Education

IRGs, initiatives, and seed projects supported by CMSE include research assistantships for graduate students. CMSE provides additional funds to support two or three assistantships per year for graduate students who are from underrepresented minority groups. The center currently funds a graduate student in Mechanical Engineering who is working on IRG research and one in Electrical Engineering and Computer Science who is performing initiative research. An additional student working on IRG research receives summer support from CMSE to bridge his academic year funding. By providing research assistantships specifically earmarked for minority students, CMSE aims to increase minority student participation in MRSEC research programs. Because the support for a minority student is supplemental to a faculty member's existing CMSE research funds, CMSE provides additional incentive for its faculty to seek minority students as research assistants.

The center's SEFs play a special role in the training of MIT graduate and undergraduate students. CMSE investigators use these facilities to carry out MRSEC research, and often this requires skilled use of state-of-the-art equipment by graduate and undergraduate student researchers. SEF staff and MRSEC-affiliated faculty provide training for new users and, in some cases, extensive graduate courses are offered on a particular technique, such as electron microscopy. Educational use of SEFs is an integral part of laboratory subjects in the DMSE's undergraduate program. Each SEF offers at least one mini-course during MIT's Independent Activities Period (IAP) in January to train students to operate the equipment and apply the latest techniques to their research problems. The SEF staff taught seven such courses during January of 2002.

Colloquia

CMSE continues its colloquium series focusing on MRSEC research. The objectives of the colloquium series are to highlight the interdisciplinary nature of CMSE's research; to provide an opportunity for faculty, research staff, and students from different disciplines to meet on a regular basis to discuss their approaches to materials problems; and to inform the greater MIT community about materials research. A special feature during the past year was a special colloquium devoted to the center's educational outreach efforts.

Michael F. Rubner
Director
TDK Professor of Polymer Materials Science and Engineering

More information about the Center for Materials Science and Engineering can be found on the web at http://web.mit.edu/cmse/www/.

MIT/WHOI Joint Program in Oceanography

The Joint Program of the Woods Hole Oceanographic Institution and MIT offers advanced degrees in oceanography and applied ocean science and engineering. Graduate study encompasses virtually all of the basic sciences as they apply to the marine environment: physics, chemistry, geology, geophysics, and biology. Students who choose applied ocean science and engineering may concentrate in the major fields (civil, environmental, mechanical, and electrical), materials science, or oceanographic engineering. More than 160 scientists/faculty from the two institutions participate in the joint program. There are currently 111 students enrolled in the five areas of study offered in the program: biological, chemical, and physical oceanography; marine geology and geophysics, and oceanographic engineering.

Since all of the MIT faculty who are involved in the joint program are members of an academic department, their individual accomplishments and awards are reported through those departments. These include Courses I, II, VI, VII, XII, and XIII.

Title of Degrees Offered by the Program

As part of a campus-wide initiative at MIT to revisit the graduate degree list in terms of specifications of degrees being offered by the various departments and programs, the joint program has revised the list of titles of degrees offered by the program. This new list reflects the diversity of sub-disciplinary concentrations offered within the program.

Proposal for Additional Distance-Learning Facility

The Joint Program Advisory Board met on February 5. The board consists of the four heads of MIT departments involved in the program (Earth, Atmospheric and Planetary Sciences, Civil and Environmental Engineering, Ocean Engineering, and Biology), the five chairs of the relevant WHOI departments, the two directors of the program, and the WHOI assistant dean of graduate studies. Chancellor Phillip Clay attended a portion of this meeting.

The principal issues discussed were: strengthening ties between the joint program and MIT departments and finding new areas of possible cross disciplinary research, retention and recruitment of students, and finding ways to improve and upgrade the single joint program videoconferencing classroom at MIT. Recognizing how greatly the program depends on distance learning facilities, it was agreed that the current system is operating at capacity, and the program would greatly benefit from having a second dedicated video classroom on campus. A room in Building 48 was eventually identified, and after consulting with MIT Facilities and staff at MVP (MIT Video Productions), we prepared proposals to redesign and furnish the space and acquire a new videoconferencing unit, and to upgrade our existing equipment.

Design of New Business Papers, Brochure and Web Site Improvements

We initiated a complete overhaul and redesign of the program's business papers, and are creating a single joint program brochure which will be mailed to prospective students. In addition we have contracted with a design firm to make significant alterations to our current web site and add features which will greatly enhance its usage. We hope to accomplish these three goals by September 2002.

Paola Rizzoli, Director and Professor of Physical Oceanography
Ronni Schwartz, Academic Administrator, Provost's Office

More information about this program can be found on the web at http://web.mit.edu/mit-whoi/www/.

Nuclear Reactor Laboratory

The Nuclear Reactor Laboratory (NRL) is an interdepartmental center that operates a 5 MW research reactor in support of MIT's educational and research missions. This reactor, which is designated as the MITR, is a heavy-water reflected, light-water cooled and moderated nuclear reactor that utilizes flat, plate-type, finned, aluminum-clad fuel elements. The average core power density is about 70 kW per liter. The maximum thermal neutron flux available to experimenters is 5 x 1013 neutrons/cm2s. Experimental facilities available at the MITR include two medical irradiation rooms, beam ports, automatic transfer facilities (pneumatic tubes), and graphite-reflector irradiation facilities. In addition, several in-core sample assemblies are available.

The past year has been an extremely active one as well as a very productive one for the NRL. As previously reported, the relicensing of the MITR with a concomitant upgrade in power is in progress. The process of relicensing is long and arduous and involves many interactions and communications between the NRL and the US Nuclear Regulatory Commission (NRC). One major form of communication is a series of questions (from the NRC) and answers (provided by the NRL) on technical specifications and safety analysis. The NRL is currently responding to the third installment of the first set of questions received from the NRC. Until this process is completed, the NRC has authorized the continued operation of the MITR pending its review. That mode of operation has been ongoing since 1999 when the relicensing request was filed. In conjunction with the relicensing effort, many reactor systems were upgraded, augmented, and/or replaced. These efforts are continuing and in the past year include: an upgrade to the neutron chopper that is used primarily by the Junior Physics Laboratory for student experiments; acquisition from the Brookhaven National Laboratory of a hot cave (small hot cell) specifically for creating an in-core sample extraction system (ICSES); and acquisition of a special cask capable of withdrawing in-core samples and transferring them to the hot cave. Also, the thermal beam located in the reactor's basement was reconstituted.

In order to support the future of the MITR and university research reactors in general, John A. Bernard, Director of the NRL, worked diligently with members of the MIT Administration, the MIT Nuclear Engineering Department, the university research reactor community, and the US DOE. As a result of these actions and a subsequent recommendation by the Nuclear Engineering Research Advisory Committee (NERAC), the Innovations in Nuclear Infrastructure and Education (INIE) Program was established to provide qualified universities and reactor facilities with funds to improve instrumentation; to maintain highly qualified research reactor staff; to establish programs that fully integrate the use of university research reactors with nuclear engineering education programs; and to establish internal and external user programs. In response to this initiative, a major proposal was prepared by John Bernard in coordination with MIT's vice president of research Alice P. Gast, Professor Jeffrey P. Freidberg and other faculty from MIT's Nuclear Engineering Department, as well as others from departments across campus. This proposal was submitted in March 2002 and the results of the awards were recently announced. The NRL proposal was one of four chosen out of the 13 that were submitted to be funded under the INIE Program. This means that over the next five years, the NRL should receive over $9 million in DOE INIE funds. The universities chosen to receive these INIE funds were expected to be and hence are in partnership with national laboratories, other universities, and industry. The NRL partnered with Rhode Island Nuclear Science Center. The INIE funds offer the opportunity for the MIT-RINSC collaboration to carry out frontier research and educational training in a number of areas vital to the well being of the nation.

Neutron capture therapy for cancer research, directed by Professor Otto K. Harling, continued for the 15th year with strong support from federal agencies. In the last year, significant progress was made in the development of this cellular tumor targeting therapy. The new fission converter based epithermal neutron irradiation facility (FCB) at the MIT Reactor was fully characterized and otherwise readied for clinical studies. The dosimetric characterizations verified that the beam from this facility combines the highest intensity of any such facility in the world with near optimum beam purity. During the year all necessary approvals were finalized for the initiation of clinical trials. These trials will be carried out under the medical direction of Dr. Paul M. Busse from the Harvard Medical School affiliated Beth Israel Deaconess Medical Center. Two separate clinical trials are now open for subject accrual. One trial is for intracranial gliobastoma multiforme and metastatic melanoma, and the second trial is for metastatic melanoma on the peripheries. Both trials are funded and approved by the National Cancer Institute. The US Department of Energy provides funding for the staff and infrastructure needed to support these clinical trials and other neutron capture therapy research centered at the MIT Reactor.

The USDOE is also supporting Professor Harling's group in the upgrading of a second neutron beam at the MITR. This beam is a high intensity thermal neutron beam to be used for small animal irradiations and clinical studies of skin cancer therapy.

The MIT/Harvard program in neutron capture therapy is the leading research program in this field in the US and is acknowledged as one of the leading programs in the world.

Security and Safety Systems

The MITR has an outstanding safety and operating record that is evidenced by the results of inspections by the US Nuclear Regulatory Commission, the results of which are shown in Table 1 for the last five years. However, after the 9/11 terrorist attacks on the United States, security and operating procedures at nuclear power plants and nuclear research facilities including university research reactors were intensely scrutinized. Consequently, John Bernard, the Director the NRL, with the assistance from the MIT News Office and the MIT Administration, had to take on the additional task of educating various regional and local government officials, the media, as well as the general public about safety and security at the NRL. This was accomplished through a series of interviews, tours, lectures, and press releases. A lecture on radiation detection was also offered to local fire department HAZMAT personnel. Equipment upgrades were also made.

Neutron Beam Tube Research

The prompt gamma neutron activation analysis facility was used both for research and in support of the neutron capture therapy clinical trials.

Environmental Research and Radiochemistry

Dr. John A. Bernard and Dr. Lin-Wen Hu have taken on the role of overseeing operation of the NRL's environmental research and radiochemistry laboratories until a permanent senior scientist is hired to supervise this very important NRL facility. The MITR is currently equipped for both prompt and delayed gamma neutron activation analysis. Relative to the former, a prompt gamma spectrometer was built as part of the Neutron Capture Therapy Program to measure the boron content in the blood and tissue of patients and experimental animals. The facility is available to other users. Relative to the latter, the MITR is equipped with five pneumatic tubes that are used for NAA. One offers a thermal flux of 5x1013; the other four offer thermal fluxes of 8x1012. Several of the tubes are automated so that samples can either be ejected to a hot cell within the reactor containment or else transferred via a pneumatic tube to a laboratory in an adjacent building. In addition to the pneumatic tubes, there are four water-cooled facilities in which large numbers of samples can be simultaneously irradiated in a uniform flux. Samples in these facilities are rotated.

The NRL NAA laboratory has 4 Hp(GeLi) detector systems with Genie-2000 software. A new computer and new software have been approved for purchase. Two detectors were rebuilt and installed this year and repair and upgrade for two additional detectors has also been approved. MIT also participates in the US Department of Energy's Reactor Sharing Program and the bulk of those funds is used to cover irradiation charges for NAA-based research.

Table 1. MITR Inspection Record 1996 –2001

Date of Inspection	Inspection Type	Result
06/10/96	Inspection on Shipping/Effluents/RRPO	No deficiencies.
08/21/96	Tour for Non-power Directorate	Tour only.
09/16/96	Inspection on Reactor Operations/QA	No deficiencies.
04/07/97	Inspection RRPO/BNCT	No deficiencies.
09/16/97	Inspection on Safeguards	No deficiencies.
09/02/97	Licensing Exams	5 RO + 4 SRO, all passed except one RO who passed a subsequent makeup exam.
11/18/97	Inspection on Reactor Operations	No deficiencies.
09/08/98	Licensing Exams	4 RO + 3 SRO, all passed.
10/21/98	Visit on Fission Converter SAR	Discussion only.
12/07/98	Inspection on Emergency Prep./RRPO	No deficiencies.
03/30/99	Inspection on SNM	No deficiencies.
06/28/99	Inspection on RRPO/Requal./Safeguards	No deficiencies.
09/30/99	Licensing Exams	3 RO + 1 SRO, all passed.
04/28/00	Inspection of Fission Converter	No deficiencies.
09/05/00	Licensing Exams	3 RO + 4 SRO, all passed except one SRO.
01/22/01	Inspection on Reactor Operations/Requal./Safeguards	No deficiencies.
10/28/01	Inspection on RRPO/Security	No deficiencies.
09/04/01	Licensing Exams	3 RO + 2 SRO, all passed.

Notes: 1. RRPO is Reactor Radiation Protection Office.

2. QA is quality assurance.

3. SAR is Safety Analysis Report.

4. SNM is special nuclear material.

Table 2. Ongoing Research Using NAA at the MITR

Institute	NAA Activity
Beth Israel/Deaconess Medical Center	Analyses of small animal and tissue cultures as well as biopsies from patients for research on neutron capture therapy (Dr. Robert G. Zamenhof, and Dr. Paul M. Busse)
Boston College	Geochemical analysis of rock and soil samples to determine the abundance of a suite of trace elements such as Co, Cr, Sc, Rb, Ss, Ta, Hf, Th, U and the Rare Earth Elements as natural tracers of a variety of different geological processes in igneous and metamorphic geochemistry and soil studies. (Professors Hepburn and Hon)
California Institute of Technology and University of Alabama	Irradiation of ashed liquid scintillator materials to study trace amount of impurities for neutrino research. Sensitivity of the trace elements (U-235/Th-232/K-40) in the material can be analyzed down to 10^{-14} g/gram.
Children's Hospital	Cu-64 is prepared by neutron irradiation of natural-abundance copper metal as a means to evaluate new copper complexes for testing as possible PET imaging agents for multi-drug resistance in cancer (Alan P. Packard, Ph.D.)
Fairfield University	Neutron activation analysis of trace elements in subsurface water supplies. (Professor Jack Beal)
Harvard University	Irradiation of tin samples enriched with Sn-112 which will serve as a source of monoenergetic conversion electrons for research conducted by Professor Boris G. Yerozolimski/High Energy Physics Laboratory.
Massachusetts General Hospital	NAA Measurements of Na and Gadolinium contents in calf nasal cartilage to investigate diffusion of various gadolinium chelate MRI contrast agents. (Dr. Xudong Huang)
MIT	In vivo boron quantification by NAA for use in BNCT Synovectomy used for arthritis research (Professor Jacquelyn C. Yanch (NED))
	Analysis of water and sediments from Boston area as a student lab and analysis of plate tectonics through the origins of lavas. (Professor Frederick Frey (EAPS))
	Evaluation of actinide element concentration in environmental and industrial samples. (Professor Kenneth R. Czerwinski (NED))
	NAA analysis of brain tissue to investigate a possible link between mercury and autism. (Dr. John Muchusak, MIT)
Tufts University and MIT	Use of neutron activation analysis for bromine measurements was provided to evaluate intra/extra-cellular water as an indicator of overall human health. (Professor Joseph Kehayias (Tufts) and Senior Research Scientist Richard Lanza. (MIT NED)).
UMass-Lowell, Lowell, MA	Irradiation of NaOH for contamination and control exercise. (Professor Clayton French)
	Use of rare elements as environmental tracers for sewage and other discharges to aquatic systems. (David K. Ryan, Ph.D.)
University of Utah	Irradiation of coal ash samples for research. (Professor JoAnn Lighty and Sheree Swenson)
Washington University	Analysis of scandium particles to study the flow pattern in high pressure slurry bubble column reactor and gas-solid riser. (Professor Muthanna Al-Dahhan)
Woods Hole Oceanographic Institute	Analysis of deep sea sediments and sea water and marine particulate matter for Pa-231. Production of Pa-233 using neutron irradiation of Th-232 to use as a tracer for isotope dilution ICP-MS. (Professor Alan Fleer)

The NRL makes its neutron activation analysis (NAA) facilities and expertise available to industry, other universities, private and governmental laboratories, and hospitals. Research and/or service-oriented collaborations were continued with several MIT research laboratories as well as with other educational and research institutions including: Harvard, California Institute of Technology, Tufts University, University of Utah, University of Connecticut, and the Woods Hole Oceanographic Institute. Table 2 shows some of the NAA projects that were either completed this year or are ongoing.

Within MIT, research support has been provided to several departments. This research support includes analysis of various environmental and biological samples for trace and toxic metals by faculty from several departments including the Department of Civil and Environmental Engineering and the Department of Chemical Engineering. In addition, Professor Kenneth C. Czerwinski (Nuclear Engineering Department) and several students use both gamma and neutron irradiation for the study of possible host matrices for use in waste storage.

Nuclear Medicine

Several state of the art neutron facilities for NCT research that have been developed are in operation at the MITR. The recently constructed epithermal neutron irradiation

facility (FCB) is now licensed by the US Nuclear Regulatory Commission. It has an intensity of ~5x109n/cm2-sec with low inherent beam contamination which approaches the theoretical optimum. If the FCB is used at maximum intensity, tissue tolerance can be reached in less than 10 minutes. The high beam purity results in a useful treatment depth of ~9 cm, using current capture compounds. Therefore, the FCB is well suited to treating deep-seated cancers. The FCB is currently the only operating US epithermal neutron beam which is suitable for clinical studies. It is also currently the best NCT epithermal neutron beam in the world. A high intensity, ~1x1010n/cm2-s, and low contamination thermal neutron beam is also available at MITR. This facility has its own medical irradiation room separate from the FCB's irradiation room. The thermal neutron facility is well suited for small animal studies and for clinical studies of NCT where tumors are less than ~4 cm deep. There is currently no other comparable facility for thermal neutron irradiations in the USA. The third neutron facility available at MITR is a prompt gamma neutron activation analysis facility. This facility is designed for rapid 10B analyses in small samples of blood and tissue. These analyses are essential for NCT research and for accurate dosimetry in clinical studies. A high sensitivity of ~18 cts/s/µgm allows rapid and accurate analyses of samples as small as 0.1 ml with typical 10B concentrations of 10 ppm. An ICP-AES, and ICP-MS are also available at the NRL and are particularly well suited to very small samples, <0.1 ml. A specialized irradiation facility for use in high-resolution track etch autoradiography is also available at MITR. High resolution quantitative track etch autoradiography developed in the Harvard/MIT program (HRQAR) permits the mapping of the microscopic boron concentration in tissue with a spatial resolution of about two micrometers. This is an invaluable aid in determining the potential effectiveness of neutron capture compounds.

Radiation Health Physics

The NRL supports a subdiscipline in the Nuclear Engineering Department (NED), Radiation Health Physics, by providing relevant research opportunities. The NRL also contributes to a specially designed laboratory and demonstration course. This course, 22.09/22.104 Principles of Nuclear Radiation Measurement and Protection, is appropriate for all students in NED. Research topics and support for Health Physics students were provided by NRL projects, especially the BNCT and Dose Reduction projects of Professor Otto K. Harling.

Dr. John A. Bernard, who is certified as a health physicist by the American Board of Health Physics, continued to teach course 22.581 Introduction to Health Physics. This course uses the MIT Research Reactor to provide practical examples of health physics issues.

In-Core Materials Studies

The NRL has a unique technical capability that involves the use and installation of in-core loops that replicate PWR/BWR conditions to study the behavior of both advanced materials and micro-particles of advanced fuels for Gen IV reactors. With rekindled national interest on the part of DOE and the nuclear industry in next generation nuclear power systems, many using novel materials and advanced forms of fuels, facilities are needed to test material and fuel behavior in a variety of radiation environments. The MITR is arguably the best suited university reactor for carrying out such basic studies because of its relatively high power density (similar to an LWR), the capability to control the chemistry and thermal conditions to reflect prototypic conditions, its easy-access geometric configuration, and space for up to three independent irradiation tests. While similar studies could in principle be carried out at certain national laboratory reactors such as the ATR, the costs would be far greater. The reason is that large national laboratory reactors are optimized for large scale, fully integrated tests and not the smaller scale, faster turnaround basic studies needed at the earlier stages of research. Access to the high flux in the core is also much more difficult in the larger reactors because of pressurization of the core. The MITR is unpressurized and the core is only about 12 feet below the lead reactor lid.

An in-core loop to study the causes of "shadow corrosion" is now being designed and installation is expected late in 2002. This study is under the direction of Professor Ronald Ballinger.

A second in-core loop to evaluate annular core fuel designs is being designed by Professor Mujid S. Kazimi and the staff of the CANES Center. This work is funded through the DOE NERI Program and is expected to be operational in early 2003.

Reactor Organization

Dr. John A. Bernard is the Director of the NRL and also holds the title of Director or Reactor Operations. There are currently 39 individuals employed by the NRL. This is broken down into five groups. These include: 13 senior staff, nine technical support staff, four administrative support staff, two technicians, and 11 part time student operators/trainees. In general, support staff, student employees, and technicians at the NRL have specific responsibilities to either reactor administration, reactor engineering, or reactor operations. Reactor senior staff divide their expertise between Reactor Operations and Reactor Engineering. Although the existing NRL organization of responsibility has been successful in the past, the increased volume of research that will result from the INIE grant will make it necessary to further delineate responsibilities within the Reactor Engineering Group with the objective of ensuring that MIT and outside users of

the NRL have the best possible assistance in utilizing the reactor and its irradiation facilities.

Reactor Engineering

Dr. Bernard continued to teach course 22.921 Reactor Dynamics and Control, and to offer review classes on engineering fundamentals for NED students in the radiological sciences. Both activities make use of the reactor for illustrating theoretical concepts. The program on the digital control of nuclear reactors continued with thesis activity in the area of automated diagnostics. One student completed a PhD in this area during the past year. Reactor engineering staff include: Dr. Lin-Wen Hu, Mr. Thomas Newton, Dr. Gordon Kohse, and Mr. Yakov Ostrovsky.

Reactor Operations

The reactor operations group is at present the strongest that it has been in the history of the MITR-II. This is due to the strong leadership provided by the reactor superintendent, Mr. Edward S. Lau. The group consists of both full-time employees (mostly ex-Navy nuclear qualified personnel) and part time MIT students. All members of the group are licensed by the US Nuclear Regulatory Commission and most hold a senior reactor operator license. At present, there are 26 licensed individuals. The breakdown is four senior individuals (director/DRO, superintendent, reactor engineer, utilization engineer), twelve other full time people, six part time student operator trainees, and four part-time student operators. All, including the management team, perform reactor shift duties to support the 24 hours/day, seven days/week operating schedule. Fifty-five percent of the operations group is women and minorities.

In addition to the operators, there are two full time technicians for reactor mechanical maintenance.

Reactor Student Operators

The MITR has traditionally hired several undergraduates per year, usually at the end of their freshmen year. The NRL is currently training six students to become reactor operators. During this reporting period nine students have been in the training program. Three of these students have already obtained their Reactor Operator License. The training program which is directed by Mr. Frank Warmsley is rigorous and covers reactor dynamics, radiation detection, radiation safety, and reactor systems. The level of instruction is comparable to that offered in undergraduate MIT courses that cover these same topics. In addition, students are taught how to operate the MITR. Upon completion of the training program, a two day examination is administered by the US Nuclear Regulatory Commission (one day written, one day oral). Successful candidates receive a Reactor Operator License and are employed during the semester at the MITR. After the students gain experience, most are offered the opportunity to participate in a second training program that leads to a Senior Reactor Operator License (SRO). Last year two student operators received their SRO. This training program is an excellent educational opportunity because it combines theoretical study with actual work experience in the MIT tradition of graduating students who know both how to design and build systems. In addition, the students that receive the SRO license obtain management experience because they are employed as shift supervisors. Students who have completed this training program regularly state that it was one of the high points of their MIT experience.

Reactor Radiation Protection

Radiation protection coverage is provided by a separate group outside the NRL organization under the leadership of Frederick F. McWilliams. Mr. McWilliams reports to MIT Environmental Health and Safety (EHS). There are three technical people in this group.

MITR Relicensing and Redesign

The relicensing of the MITR with a concomitant upgrade in power is in progress. It was previously identified that the MITR could operate at a maximum power of 6–7 MW with the existing heat removal equipment. A decision was subsequently made to submit the licensing documents for a power increase from 5 MW to 6 MW. On 8 July 1999, a formal application was submitted to the US Nuclear Regulatory Commission (NRC) to relicense the reactor for an additional twenty years and to upgrade the power level to 6 MW. The relicensing package included a complete rewrite of the Safety Analysis Report and the Technical Specifications. The NRC has authorized the continued operation of the MITR pending its review of the application. That process remains ongoing. In conjunction with the relicensing effort, reactor systems are being upgraded. Upgrades to electrical distribution systems were initiated in 2000 and are continuing.

Reactor Irradiations for Groups Outside MIT

A number of reactor irradiations and services were performed for research groups outside MIT. Most of these represent continuations of previous research. Examples include Dr. Alan B. Packard of Boston Children's Hospital for the evaluation of copper and gold for arthritis treatments; Dr. Alan P. Fleer of Woods Hole Oceanographic Institute to determine natural actinides and plutonium in marine sediments; Dr. Rebecca Chamberlain of the Los Alamos National Laboratory for the calibration of ultra-sensitive neutron monitoring devices by thermal neutron fission of uranium foils; and isotope production for cardiovascular research by both Best Industries, Inc. (Springfield, Virginia) and Implant Sciences (Wakefield, Massachusetts).

Whereas most of the outside users pay for irradiation services at the reactor, educational institutions needing such services for their own academic or research purposes are assisted in this regard by the DOE through its Reactor Sharing Program. A grant to MIT NRL reimburses us for the costs of providing irradiation services and facilities to other not-for-profit institutions (including teaching hospitals and middle and high schools). Under this program, 500 students and 50 faculty and staff from over 30 other educational institutions benefited from visits to and use of the MITR during the past year.

Research utilization of the MITR by other institutions under the Reactor Sharing Program during the past year has included: use by Professors J. Christopher Hepburn and Rudolph Hon of Boston College to activate geological specimens and standards for the neutron activation analysis of rare earth and other trace elements in studies of the geological development of the northeastern United States; irradiation of coal ash samples for research being conducted by Professor JoAnne Lighty at the University of Utah; gamma irradiation of plant seeds for several area high school students participating in science fair projects; measurements of boron concentration and work on high resolution track etch autoradiography for Professor Robert Zamenhof of Beth Israel/Deaconess Medical Center; participation in several special high school student projects;) neutron activation analysis of subsurface water supplies by Professor Jack Beal of Fairfield University; neutron time of flight and Bragg angle measurements by Professor Martin Posner's group of the University of Massachusetts; NaOH irradiation for Professor Clayton French of UMass-Lowell; and use of neutron activation analysis for bromine measurements by Professor Joseph Kehayias (Tufts) and Senior Research Scientist Richard Lanza (MIT NED) to evaluate intra/extra-cellular water as an indicator of overall human health.

For education of the general public and students at all levels in local and other New England schools, the reactor staff provides lectures and tours periodically throughout the year.

Major Reactor Services

The MITR produces about $1.2 million worth of neutron transmutation doped (NTD) silicon per year. This is commercial income and the funds are used to offset operating costs. The market for NTD silicon remains strong despite improvements in the chemical production of the material and the MIT program continued for a successful ninth year. Approximately 10 metric tons of Si crystals were accurately irradiated in shielded, automated irradiation facilities at the MITR. This project is under the technical direction of Professor Otto K. Harling.

Affirmative Action

The NRL supports the affirmative action goals of the MIT. Of a staff of 39 there are currently five engineering and management positions held by minorities and women. The NRL participated in the US DOE's program for minority training in reactor operations, and one of our current senior reactor operators is a graduate of this program.

MIT Research Reactor

The MIT Reactor completed its 44th year of operation, its 28th since the 1974-75 shutdown for upgrading and overhaul. The reactor operated continuously (seven days per week) to support major experiments. On average, the MIT Reactor was operated 122 hours per week at its design power level of 5 MW. Energy output for the MITR-II, as the upgraded reactor is now called, totaled 544,000 megawatt-hours as of June 30, 2002. The MITR-I generated 250,445 megawatt-hours in the sixteen years from 1958 to 1974.

The senior reactor staff continued to be active in the nuclear field. Dr. Bernard remained active in the American Nuclear Society (ANS) and Dr. Lin-Wen Hu was elected Chair of the Isotopes and Radiation Division of ANS. Her term began in June 2002.

To summarize briefly the reactor was well utilized during the year, although still more experiments and irradiations can be accommodated because of the number and versatility of the many experimental facilities. The number of specimen irradiations was 322. There were 57 irradiations in the medical rooms, many in support of the neutron capture therapy program for the treatment of brain cancer and subcutaneous melanoma. Theses and publications on research supported by the reactor are running at about five and 20 per year, respectively. Approximately 1300 people toured the MIT Research Reactor from July 1, 2001 through June 30, 2002.

John A. Bernard
Director

Operations Research Center

The Operations Research Center (ORC), established in 1953 as a first-of-a-kind interdepartmental graduate degree program, completed its 49th year of operation in 2001–2002. The center administers its own graduate programs and a varied research program of methodological and applied projects. It maintains a reading room with a small library, as well as state-of-the-art computational workstations.

This report summarizes the center's 2001–2002 activities and briefly reviews its educational, research and outreach programs.

Faculty, Students, Staff

Professor James B. Orlin, Edward Pennell Brooks professor of operations research and Cynthia Barnhart, associate professor of civil and environmental engineering served as co-directors during 2001–2002.

This year the ORC had 44 affiliated faculty and senior staff, with faculty drawn from the School of Management and the Departments of Electrical Engineering and Computer Science, Civil and Environmental Engineering, Ocean Engineering, Mathematics, Aeronautics and Astronautics, Mechanical Engineering, Nuclear Engineering, and Urban Studies and Planning.

The Operations Research Center offers two interdepartmental graduate degree programs, a PhD and a master's degree. During 2001–2002, these programs enrolled 45 students—39 PhD candidates, and six SM candidates. The ORC also hosted one special student. The center conferred four master's degrees and six PhDs. Several other PhD theses were in the final stages of completion in the summer of 2002.

Academic Programs

The ORC's academic programs continue to be recognized as ranking among the very best nationally and internationally. The program, moreover, is repeatedly cited as achieving an excellent balance between application and methodological domains.

Research Activities

Research activities spanned a wide spectrum of methodological topics and applications, ranging from small, unsponsored projects involving a single faculty member supervising a student's thesis, to much larger sponsored programs involving several faculty/staff and students.

Methodological research includes such topics as linear, nonlinear, and combinatorial optimization, solution methods for integer programming, interior point methods for linear and nonlinear programming; cluster analysis; parallel and distributed computation and algorithms; network flow algorithms; network design; probabilistic combinatorial optimization; deterministic and stochastic facility location; queueing theory, including queueing networks; risk analysis, stochastic processes; classical and Bayesian statistics; and decision analysis and statistical decision theory.

ORC faculty are also currently contributing to application domains as wide ranging as manufacturing, communications, transportation, public services, logistics, marketing, financial services, health care, and nuclear engineering. Current projects are addressing such topics as air traffic control, epidemiology, AIDS testing, life-cycle modeling of municipal solid waste, safety and risk analysis in air transportation, telecommunication network design, supply chain management, production scheduling, and transportation logistics.

Several organizations sponsored research projects at the ORC during 2001–2002, for example: the National Science Foundation; C.S. Draper Laboratory (several projects and Draper Fellowships); General Motors; Federal Aviation Administration's Center of Excellence for Aviation Operations Research; Logistics Management Institute; Office of Naval Research; Singapore/MIT Alliance Program; and United Airlines.

Outreach and Professional Service

In its effort to serve the professional community at large, the ORC regularly undertakes a number of outreach activities.

Professor Amedeo R. Odoni and Richard de Neufville offered a professional course in October of 2001: "Airport Systems: Strategic Planning and Detailed Design."

The Operations Research Center, and the Mathematical Programming Society co-hosted the 9th conference on Integer Programming and Combinatorial Optimization, also known as IPCO 2002. The aim of the conference is to present recent developments in theory, computation, and applications of integer programming and combinatorial optimization. The conference brought together an international group of students, faculty, and researchers. The faculty organizer for the conference was Andreas Schulz. The student coordinator was Nicolás E. Stier Moses.

The ORC Seminar Series was privileged to have many distinguished speakers from industry and academia this year. Among the many operations research professionals who made presentations were: Awi Federgruen (Columbia); Martin Grötschel (Technische Universitaet, Berlin); Laurent El Ghaoui (Univ of CA-Berkeley); Maxim Sviridenko (IBM); Yinyu Yee (Univ of IA); Adam Kalai (MIT); John Vande Vate (GA Tech); Costis Maglaras (Columbia); Katya Scheinberg (IBM); Egon Balas (Carnegie-Mellon); Michael Fu (Univ of MD); Alvin Roth

(Harvard); Jean-Louis Goffin (McGill); Andrew Boyd (PROS Revenue Management); Brenda Dietrich (IBM); Guillermo Gallego (Columbia); Jeff McGill (Queen's Univ).

The center also offered a program of activities during the January Independent Activities Period, including a series of presentations on the practice of operations research and management science presented Mitchell Burman (Analytics, Inc.); Gina Mourtzinou (Dynamic Ideas, LLC); John Ruark and Salal Humair (Optiant) and Kermit Threatte (Analytics, Inc.)

New Developments

During 2001–2002, the Operations Research Center continued the process of self-evaluation and improvement. Some of the developments during this past year are as follows:

—ORC space changes. In June 2002, the ORC transferred the space in E40-194 to the Sloan School of Management. In exchange, the Sloan School provided space for CCREMS, which in turn moved out of the ORC. In addition, the Sloan School provided funds for renovating the new ORC space for students. The result of the space exchange was that all of the students in the ORC will be located on the east half of the first floor of E40. We anticipate that this will lead to an enhanced feeling of community for all of our students.

—Probability statistics requirement. We have revised our statistics requirement to make it more flexible, taking into account students' backgrounds as well as their research focus. Students may now satisfy the requirement by taking one advanced class from a short list.

—Enhancement to computer facilities. We have purchased numerous computational workstations for the labs.

—Coordination with the MIT Forum for Supply Chain Innovation. A corporate-sponsored consortium providing research, educational software, strategy sessions, and training, the MIT Forum for Supply Chain Innovation (FSCI) has an unofficial affiliation with the ORC. We anticipate that several OR students per year will work on FSCI-supported projects.

—Coordination with faculty proposing an MEng degree in computational design and decision sciences. The faculty at the Singapore-MIT Alliance on High Performance Computing (SMA HPCES) are proposing an MEng degree in computational design and decision sciences. When we considered the possibility of its being proposed as an ORC program, the ORC faculty and the SMA HPCES faculty jointly determined that it would be proposed as a separate program.

Diversity

The ORC has always attempted to provide an environment that is responsive to the varied professional and personal needs of the OR community at MIT, and that builds upon diversity.

The ORC makes no faculty appointments. The staff of the ORC is composed of two support staff members and one administrative officer. Of these three staff, all are women, and two are African-American.

Honors and Awards

Arnold Barnett received the INFORMS Expository Writing Award. Arnie was also the recipient of an Excellence in Teaching Award at the Sloan School of Management.

Dimitris Bertsimas was the recipient of the Miller Fellowship from the University of California at Berkeley.

Ismail Chabini was the recipient of the 2002 Teaching Award from the MIT Center for Transportation and Logistics.

Vincent Chan was named a fellow of the Optical Society of America.

Richard de Neufville received an honorary doctorate from the Technical University of Delft in recognition of his role in founding and developing the MIT Technology and Policy Program. He was elected a life member of Clare Hall, a postgraduate college at Cambridge University. In addition, Richard was the recipient of the Best Teacher Award from the Technology and Policy Program.

Eric Feron received a best conference paper award for "Design and Applications of an Avionics System for a Miniature Acrobatic Helicopter," coauthored with K. Sprague, V. Gavrilets, D. Dugail, B. Mettler, and I. Martinos.

Stanley Gershwin received the IIE Best Paper Award and the Outstanding IIE Publication Award for his paper "Design and Operation of Manufacturing Systems—The Control-Point Policy."

John Hauser received the Parlin Award from the American Marketing Association (AMA). This is the AMA's oldest and most prestigious award and is given for lifetime contributions to the field of marketing research.

Richard C. Larson served for two weeks as the Sir Edward Youde Memorial Fund Visiting Professor at Hong Kong University. The Youde Professorship, awarded annually, was established in 1995 to provide more opportunities for education and cultural exchanges between Hong Kong and the global academic community.

Andrew Lo was named the IAFE/Sungard Financial Engineer of the Year. In addition, he was awarded a Guggenheim Fellowship.

Amedeo Odoni received the Robert Herman Lifetime Achievement Award in Transportation Science. This award is granted to an individual who throughout his/her professional career has made fundamental and sustained contributions to transportation science, and has influenced the field through his/her writings, teaching, service, and nurturing of younger professionals.

Georgia Perakis was the recipient of the MIT Graduate Student Council Teaching Award for the Sloan School of Management.

Alex Samarov received a Fulbright grant for teaching and research at Tel Aviv University in Israel during February–June 2002.

David Simchi Levi's book Desigining and Managing the Supply Chain, coauthored with P. Kaminsky and E. Simchi-Levi, was selected by Business 2.0 as "the best source for slashing time and costs and increasing productivity in the supply chain."

Andreas Schulz was named the Class of 1958 Career Development Professor. This professorship recognizes and encourages innovative and imaginative teaching by gifted young faculty members. Also, Andreas received the Meritorious Service Award from the journal Operations Research for "high-quality and timely work" as associate editor.

Santosh Vempala received an Alfred P. Sloan Foundation Fellowship.

Alp Muharremoglu took first place at the George Nicholson Student Paper Competition, awarded by INFORMS for the best paper in operations research and the management sciences written by a student.

Andrew Armacost, an ORC alumnus, was the winner of the Dantzig Prize and received second prize in the INFORMS Transportation Science Section Dissertation Prize.

In addition to these awards, many of our faculty members received promotions during the last academic term. Cindy Barnhart was promoted to full professor; Ismail Chabini was promoted to associate professor; John Paul Clarke was promoted to associate professor; Michel Goemans was promoted to full professor; and Georgia Perakis was promoted to associate professor.

Cynthia Barnhart, Co-director and Professor of Civil and Environmental Engineering
James B. Orlin, Co-director and Professor of Management Science

More information about the Operations Research Center can be found on the web at http://web.mit.edu/orc/www/.

Plasma Science and Fusion Center

MIT's Plasma Science and Fusion Center (PSFC) is known internationally as a leading university research center for the study of plasma and fusion science and technology. Research activities are underway in five major areas:

- magnetically confined plasmas in the development of fusion energy
- the basic physics of plasmas, including magnetic reconnection experiments on the VTF facility, new confinement concepts such as the Levitated Dipole Experiment (LDX), development of novel high-temperature plasma diagnostics, basic laboratory and ionospheric plasma physics experiments, and theoretical research
- fusion technology and engineering development, addressing problems in areas such as magnetic systems, superconducting materials, and system studies of fusion reactors
- plasma-assisted conversion of hydrocarbon fuels into hydrogen, and development of environmental remediation techniques based on plasma technology
- the physics of waves and beams, including gyrotron and high-gradient accelerator research, beam theory development, non-neutral plasmas, and coherent wave generation

PSFC's research and development programs are supported principally by the Department of Energy's Office of Fusion Energy Sciences. There are approximately 258 personnel associated with PSFC research activities. These include 19 faculty and senior academic staff, 47 graduate students, and nine undergraduates, with participating faculty and students from the Electrical Engineering and Computer Science, Materials Science and Engineering, Mechanical Engineering, Nuclear Engineering, and Physics Departments; 67 research scientists, engineers, and technical staff; 62 visiting scientists and engineers, postdoctoral associates, and research affiliates; 30 technical support personnel; and 24 administrative and support staff.

PSFC's research funding was $27 million in FY2002, up 4.2 percent from $25.9 million in FY2001. The increase was due mainly to a new industrial contract in the plasma technology area to accelerate the development of the "plasmatron" concept. Based in part on preliminary budget guidance from OFES, we estimate that PSFC's total funding in FY2003 will increase by nearly 15 percent to $31 million. The primary cause of this jump is an expected increase (dependent on congressional appropriation) of about $4.5 million in the Alcator Project budget, which we expect should remain at that funding level for the indefinite future. In addition, a growing niche at the PSFC in inertial confinement fusion (ICF) research is expected to contribute nearly $1 million to the budget increase in FY2003.

Alcator Division

The Alcator C-Mod tokamak is a major international fusion experimental facility, directed by Professor Ian Hutchinson and Dr. Earl Marmar. It continued its research in high-performance, compact magnetic plasma confinement. The upgrade to permit quasi–steady state exploration of advanced tokamak operation with high fractions of self-generated current is nearing completion, under the leadership of Professor Ronald Parker. The 4.6 GHz, 3 MW RF sources and associated power supplies are now installed, and the wave launcher, being fabricated by our PPPL collaborators, is due for installation in March 2003.

C-Mod is recognized as one of three major US national fusion facilities. The team includes approximately 16 MIT staff scientists, 18 MIT graduate students, 18 engineers, and 25 technicians. In addition we have collaborators from around the world, bringing the total number of scientific users of the facility to about 120.

The facility operation this year has been limited, in part, by a scheduled disassembly for inspection of the magnet and upgrade of the divertor and other structures for higher current operation, increased shape flexibility and improved diagnosis of the plasma. This engineering work was successfully completed. However, the more fundamental limitation to operation has been funding. Recognizing this problem, the Office of Fusion Energy Sciences of the US Department of Energy put forward a plan for substantial increases in funding for fiscal year 2003. The presidential budget proposed an increase of approximately $4 million for the facility, to enable a major increase in operations time, moving towards full utilization. Funding for this proposal has not yet been appropriated by Congress, and if it would be, we are planning 21 weeks of operation in FY2003.

Highlights of Recent Research Achievements

We have shown that the particle transport in the core of the plasma is reduced by putting the main source of heating about half way out from the center of the plasma. In C-Mod this heating is the absorption of radio frequency waves through resonance with the cyclotron motion of the ions about the magnetic field. This process is naturally quite localized at a position where the frequency is equal to the ion cyclotron frequency. By changing the magnetic field, the resonance position can be moved. We find that with off-axis heating, the particle density peaks up slowly in the center of the plasma, consistent with a reduction of diffusivity, and the consequent effects of the known trapped particle pinch. More exciting still, we have shown that by applying heating at a second frequency, chosen to heat the plasma center, we can control the peaking of the density profile, and produce a stationary peaked profile. This result shows that the density profile can be actively controlled—a long-standing objective of transport research in tokamaks.

A new turbulence imaging diagnostic has revealed new features of transport near the edge of the plasma. The plasma is imaged using a fast camera with exposure times as short as a few microseconds. Short wavelength density perturbations are observed that show persistent blobs moving in time. This phenomenon, referred to generally as "intermittency," is characteristic of the edge turbulence and provides important evidence for its underlying causes. In related research, the plasma turbulent transport outside the confined regions has been seen to be dominated by the intermittent transport phenomenon, and to be much more important than previously thought. Our experiments have shown that the blobs are capable of transporting much more plasma across to the solid surfaces of the main chamber than had been realized. This observation is important because it will affect the design of future experiments and their plasma-facing components.

Short wavelength waves mode converted at critical resonance layers from the externally launched RF heating waves (themselves a form of compressional Alfven wave) have been measured by phase contrast imaging (PCI) techniques. Full wave modeling, using state-of-the-art parallel computer programs, has shown that in toroidal geometry these wave phenomena are more complicated than had been thought. In particular, coupling to both electrostatic ion Bernstein waves, as well as to electromagnetic ion cyclotron waves may be possible. The observations with PCI are consistent with the latter type of wave, in agreement with the code modeling results and earlier theoretical predictions based on slab geometry with sheared magnetic fields. This work has important implications for the future use of short wavelength mode converted waves for plasma transport control.

A new neutral beam injector for diagnostics was installed. This beam was designed and fabricated by the Budker Institute in Siberia, and is part of a collaboration with the University of Padua.

The process leading to renewal of the Alcator five-year research grant (due at the end of 2003) began with a US Tokamak workshop, held in May 2002, where the research plans were presented and discussed. The formal proposal will be submitted to DoE in December 2002.

Physics Research Division

The Physics Research Division, headed by Professor Miklos Porkolab, seeks to improve our theoretical and experimental understanding of plasma physics and fusion science. This division develops basic plasma physics experiments, new confinement concepts, novel inertial fusion diagnostics, and space plasma physics experiments, and is the home for a strong basic and applied plasma theory and computations program.

Fusion Theory and Computations

The theory effort, led by Dr. Peter Catto, supports Alcator C-Mod and other tokamak experiments world wide, the Levitated Dipole Experiment (LDX) nearing completion at the PSFC, and the PSFC's Versatile Toroidal Facility (VTF), where basic plasma science experiments are conducted. New participants in the theory program include Professor Kim Molvig of Nuclear Engineering who joined the PSFC theory program, and hires Doctors Darin Ernst and John Wright in the turbulence and computational science area. Many important contributions have been made by the group during the past year and a few of these are highlighted below.

Tokamak Confinement and Transport

Important advances have been made in understanding the physics of internal transport barriers (ITB) that have been triggered in Alcator C-Mod by the application of off-axis ICRF heating power. ITBs correspond to formation of an "internal density barrier" despite the absence of any source of central fueling. By means of state of the art stability and transport code analysis it has been demonstrated that the density peaking observed during ITB mode formation is consistent with a reduction in particle diffusivity within the barrier region, combined with an inward pinch velocity.

In the tokamak edge studies we have focused on the impact of penetration of neutral atoms and molecules into the steep plasma density gradient region just inside the separatrix in an attempt to understand their influence on sheared flow observed at the edge in reduced transport regimes. The effect of the neutrals on the toroidal ion flow and radial electric field just inside the separatrix was evaluated by extending our earlier treatments to arbitrary mean free path neutrals and by allowing poloidal variation of the neutral density. We have found that the localization of the neutrals to a penetration depth results in a strongly sheared toroidal ion velocity and radial electric field which may locally reduce turbulent transport.

Magnetohydrodynamics, Stability, and Integrated Advanced Tokamak Physics

A key element of the advanced tokamak program on Alcator C-Mod will be non-inductive current driven lower hybrid (LH) waves. In support of these current profile control experiments we have initiated an integrated scenario modeling effort aimed at the development of combined models for LH current drive, predictive transport analysis, ion cyclotron radio frequency (ICRF) heating, and ideal magnetohydrodynamic (MHD) stability. In addition, we have investigated resistive wall mode (RWM) stability with various poloidally varying flow configurations and found that stability threshold is reduced to a lower critical flow than axial flow cases. RWMs occur in reversed field pinches as well as tokamaks, are sensitive to plasma rotation, would be ideal MHD unstable in the absence of a conducting wall,

are stabilized if the wall is perfectly conducting, and grow on the resistive wall time if the wall has finite resistivity. In another theoretical work, we have gained further insight into the so called quasi-coherent mode observed in the favorable enhanced D-alpha operating regime of Alcator C-Mod.

Heating, Current Drive, and Nonlinear Dynamics

Principal research scientist Dr. Paul Bonoli received new funding through the Office of Fusion Energy Science's Scientific Discovery Through Advanced Computing Initiative ("Sci-Dac"). Dr. Bonoli and coworkers are continuing to implement state of the art simulation models for current drive, heating, and mode conversion in the ion cyclotron and lower hybrid (LH) range of frequencies. These codes are used extensively by the Alcator C-Mod group to analyze ICRF heating and mode conversion experiments as well as assess planned LH current profile control experiments. Moreover, their full wave electromagnetic field solver has been successfully used to resolve, for the first time, mode converted ion Bernstein waves and electromagnetic ion cyclotron waves in toroidal geometry.

RF Wave Propagation in Spherical Tokamaks

The nature of tight aspect or "spherical" tokamaks does not allow for the conventional electron cyclotron waves—ordinary O and extraordinary X modes—to effectively heat and/or drive currents. Professor Abe Bers and Dr. Abhay Ram have shown that these limitations can be overcome by coupling power to electron Bernstein waves (EBWs) since they damp very effectively on electrons in the vicinity of the Doppler shifted electron cyclotron resonance (or its harmonics). This strong localized absorption also implies that thermal emission of EBWs can also occur. They have been studying details of the mode conversion and emission processes to determine the optimum operating regimes. Since EBWs are not vacuum modes, the possible means for coupling power to EBWs are via mode conversion of an externally launched O and X modes. Similarly, emitted EBWs propagate out to the edge of the plasma and mode convert to experimentally observable X and O modes near the upper hybrid resonance.

LDX Stability, Heating and Confinement

The confinement of high pressure plasma by the dipole magnetic field produced by a levitated superconducting ring offers a new and unorthodox approach to steady state magnetic confinement. The recent dipole research in support of LDX led by Dr. Jay Kesner has focused on equilibrium and stability issues to gain an understanding of the allowed operating regimes. The MHD studies found that dipole equilibria are remarkably stable at arbitrary plasma pressure provided the pressure gradient is sufficiently weak so that it remains below the ideal MHD interchange limit. When the pressure profile exceeds the interchange mode stability limit we expect the formation of large scale convective cells leading to non-local transport. When kinetic treatments are employed to retain diamagnetic and magnetic drift effects in dipoles, the closed field line entropy modes are excited, which, unlike MHD modes, do not keep the entropy constant. Although they restrict the stable operating regime for LDX, a large operating space remains stable and persists even in the semi-collisional and collisionless limits. When parallel and perpendicular resistivity are turned on, weak resistive modes may be unstable. The impact of these modes remains to be investigated.

Experimental Research

Levitated Dipole Experiment

The levitated dipole experiment (LDX) represents a new and innovative approach to magnetic fusion, which will utilize a levitated superconducting coil to confine plasma in a dipole magnetic field. LDX is a joint collaborative project with Columbia University that is located in NW21 at MIT. The principal investigators of this project are Dr. Jay Kesner of MIT and Professor Michael Mauel of Columbia University. The LDX facility has been designed by the engineering division of the Plasma Science Fusion Center (PSFC) under the leadership of Dr. Joseph Minervini.

The concept was inspired by observations that high-pressure plasmas can be confined by planetary dipole magnetic fields, such as the magnetosphere which surrounds Jupiter. Compared with the traditional fusion approaches, the levitated dipole may permit the confinement of plasmas with higher beta values (the plasma to magnetic field pressure ratio) and with reduced cross-field transport. The project has been funded as a six-year grant at an approximate annual budget of $1.4 million (shared between MIT and Columbia University). The construction of the project will be completed during the initial five-year period. When completed, LDX will be the only superconducting magnetic confinement experiment in the American fusion research program.

The design of the facility was largely completed during FY1998 and the construction and assembly is nearly complete. The vacuum chamber is in place in the Tara cell of NW21. The high-performance Nb3Sn floating coil has been successfully tested and the cryostat is nearly completed. The (high temperature superconductor) levitation coil is expected to be completed by October 2002 and the NbTi charging coil is expected to be arriving at MIT by November 2002. The first plasma results are expected early in CY2003.

Magnetic Reconnection Experiments on the Versatile Toroidal Facility (VTF)

Fast changes of magnetic field topology are observed in association with reconnection phenomena both in space and laboratory plasmas, e.g. in solar flares, magnetic substorms at the geo-magnetic tail, and in the case of internal disruptions in fusion tokamak devices. The basic plasma experiment VTF, founded by Professor A. Fasoli and now led by Dr. J. Egedal, has in the past year provided significant new insight into the fundamental mechanisms which allow magnetic field lines to break and reconnect at rates orders of magnitudes higher than the classical rate. During the driven reconnection experiments the collisionless plasma is characterized in terms of space and time evolution of magnetic fields, currents, density and electric potential. The unprecedented accuracy and time resolution of these measurements has formed the basis for the first direct test of two fluid plasma theories against experimental data. The data suggests that stress terms in the pressure tensor are important for the momentum balance of the. Stimulated by these experimental results theoretical effort is now underway to determine if the stress terms can account of the high rates of reconnection observed. Finally, a new proposal was submitted to DOE-OFES by Professor Porkolab and Dr. Jan Egedal to obtain additional funding for these experiments.

MIT-PSFC/JET Collaboration on Alfvén Wave Instabilities

This program (led by Professor Fasoli) conducts experiments at the Joint European Torus (JET), the world's largest tokamak in England. In these experiments instabilities driven by high energy particles, such as neutral beam ions, RF driven energetic ions and ultimately, alpha particles, are studied. These studies lead to an improved understanding of plasma stability and transport that will be important in a burning plasma experiment where the fusion process generates a substantial alpha particle component

Inertial Confinement Fusion Experiments

MIT's effort in inertial confinement fusion, led by Dr. Richard Petrasso, is a collaboration with the University of Rochester and Lawrence Livermore National Laboratory. This program has continued to produce exciting results on experiments conducted at the OMEGA laser facility at the Laboratory for Laser Energetics at the University of Rochester. MIT has been responsible for designing and implementing two very large charged-particle spectrometers, and nine smaller ones. Such spectrometers are used to detect charged fusion products that are generated at the core of imploding ICF capsules. From the number of such reactants (i.e. the yield), the effectiveness of the fusion process can be determined, and from the energy loss of the reactants as they pass through the capsule, a measure of the capsule compression can be determined. Both these quantities, namely yield and capsule compression, are fundamental parameters needed to characterize the quality of the implosions. In addition, since the spectrometers view the implosion from many different angles, the implosion symmetry can be studied. In recent work nine different spectrometers viewed imploding capsules and showed that significant non-spherical asymmetries exist. MIT data and analysis have contributed important insights into the relationship between experimental conditions and implosion performance and in doing so has advanced the state of ICF research. These spectrometers are prototypes for those being designed by MIT and collaborators for the National Ignition Facility (NIF) at Lawrence Livermore. For example, at the core of NIF implosions, we expect to achieve plasma densities that are six times larger than the density at the center of the sun, or 52 times more dense than gold. Finally, we note that the MIT/PSFC has the lead role in organizing and coordinating the Basic Science Users Group for the National Ignition Facility.

Novel Diagnostics for Magnetic Fusion Research

Phase Contrast Imaging Diagnostic of Turbulence on DIII-D

Professor Porkolab and collaborators have proposed new upgrades to the DIII-D collaboration in Phase Contrast Imaging of short wavelength modes, including an upgrade of the C-Mod PCI experiment. This proposal was funded at more than twice the previous funding level and the upgrading of the systems is underway.

Collective Thomson Scattering off Ions in Textor and Asdex-U

This collaboration, spearheaded by Dr. Woskov of the PSFC, has also been approved for an upgrade in a recent competitive review, and upgrading the experimental apparatus is underway in Europe and the PSFC.

Ionospheric Plasma Research

PSFC's Ionospheric Plasma Research Group (Visiting Professor Min-Chang Lee and his students) has been conducting ionospheric plasma RF heating experiments in Alaska, using DoD's HF Active Aurora Research Program (HAARP) facility. These experiments are aimed at investigating ionospheric plasma turbulence and developing ELF/VLF communication schemes for high efficiency and good quality signals. Progress has been made to determine the spatial distribution of HF-modulated electrojet currents and sources of ELF/VLF emissions. PSFC's Ionospheric Radar Integrated System (IRIS), after being tested successfully, has been deployed for experiments at Millstone Hill, Massachusetts for remote sensing of space plasma turbulence. The new optical instrument, All Sky Imaging System (ASIS), funded recently by DoD equipment grant, will be used in experiments to study the spatial structures

of plasma turbulence. ASIS together with IRIS will provide powerful diagnoses of RF heated plasmas in space and laboratory experiments.

Waves and Beams Division

The Waves and Beams Division, headed by Dr. Richard Temkin, conducts research on novel sources of electromagnetic radiation and on the generation and acceleration of particle beams. Substantial graduate student involvement is emphasized in all research programs within the division.

Gyrotrons are under development for electron cyclotron heating (ECH) of present day and future plasmas, for high frequency radar and for spectroscopy. These applications require gyrotron tubes operating at frequencies in the range 90-500 GHz at power levels of up to several megawatts.

In 2002, we started experiments with a new 110 GHz pulsed gyrotron and demonstrated operation at the power level of 1 MW in the design mode. The new continuous wave gyrotron will be tested at an industrial vendor, Communications and Power Industries.

Intensive research continues on 250-500 GHz gyrotrons for use in electron spin resonance and nuclear magnetic resonance studies. This research, funded by NIH, is a collaboration with Professor Robert Griffin of the Francis Bitter Magnet Lab. In 2002, we continued utilization of the 250 GHz gyrotron that demonstrated reliable operation for many hours at continuous wave power levels of up to 25 W. A new 460 GHz gyrotron is under construction and expected to operate in 2003.

In a new program, funded as part of a US Department of Defense MURI consortium for Innovative Vacuum Electronics, a novel 140 GHz gyrotron amplifier has been tested. Thirty kW peak power, which is the record power level above 100 GHz, has been demonstrated with a 30 dB linear gain and at a 2.1 GHz bandwidth. These results will be very useful to scientists at MIT's Lincoln Lab who are working on a high frequency amplifier for the Haystack antenna based radar.

PSFC research on high gradient accelerators is focused on high frequency linear accelerators for development of future TeV electron colliders. In 2002, the High Gradient Accelerator Group continued commissioning of the Haimson Research Corp. 17 GHz electron accelerator. This is the highest power accelerator on the MIT campus and the highest frequency stand alone accelerator in the world. The diagnostic set up is under construction to measure the electron bunches from the 17 GHz accelerator.

The Intense Beam Theoretical Group, led by Dr. Chiping Chen, has contributed to our understanding of coherent radiation generation and particle acceleration. Topics covered include coherent radiation generation in crossed field devices, control of halo formation in intense electron and ion beam transport, and the design of metallic photonic band gap structures for use in coherent radiation structures. An important recent achievement is the use of a Green's function based simulation code to determine an annular beam confinement limit for bunched electron beams in high-power microwave sources.

Plasma Technology Division

The objectives of the Plasma Technology Division, led by doctors Daniel Cohn and Paul Woskov, are to develop new fusion spinoff applications, particularly in the environmental and hydrocarbon energy efficiency area; to develop new fusion diagnostics; and to develop new fusion reactor system concepts.

A rapidly growing research area in the division is plasma assisted conversion of hydrocarbon fuels into hydrogen with Leslie Bromberg and Daniel Cohn as coprincipal investigators. Hydrogen has potential environmental advantages as a fuel or a fuel additive that can greatly reduce pollution from vehicles and stationary electricity generation systems. It can also be used to increase the efficiency of conversion of hydrocarbon fuels into mechanical power or electrical power. Special plasma technology, referred to as plasmatron reformers, can provide important advantages in facilitating the generation of hydrogen from hydrocarbon fuels.

The expanding activities in the area of plasma assisted conversion of hydrocarbon fuels are contributing to the following goals:

- Developing high-impact near-term spinoffs from fusion energy and applied plasma physics research
- Expanding collaborations between the Plasma Science and Fusion Center and academic departments and other laboratories
- Increasing industrial support for Plasma Science and Fusion Center research

A number of projects related to plasma-assisted hydrogen production from hydrocarbons are being pursued. One project, sponsored by Arvin Meritor, a major automobile components manufacturer, is investigating plasmatron reformer devices for vehicles which would use onboard conversion of gasoline to hydrogen-rich gas for cleaner, more efficient operation. The hydrogen-rich gas would then be combusted in a slightly modified spark ignition engine. Using the hydrogen-rich gas as an additive to gasoline, large reductions in NOx, a major air pollutant, can be obtained. By facilitating high compression ratio lean burn operation, the use of hydrogen rich gas could also increase net engine system efficiency by up to 25 percent. The relatively low additional cost could result in a relatively short payback time due to fuel savings.

The short payback time could potentially make possible widespread implementation on cars and light duty vehicles which could eventually lead to a gasoline savings in the United States of 20 billion gallons a year. The program involves collaboration with Professor John Heywood of the Mechanical Engineering Department and the Sloan Automotive Laboratory.

A new effort involving a substantial expansion in the collaborative program between the Plasma Science and Fusion Center and the Sloan Automotive Laboratory is being proposed to DOE. This effort would involve a broad study of new clean, high efficiency engine concepts referred to as Hydrogen Enhanced Lean Boosted Engines. Such engines could serve as a bridge to the long-term national goal of vehicles using stored hydrogen while also providing near term fuel savings as described above. The need for vehicles with significant near term fuel savings has recently been increased by legislation in California calling for reduced greenhouse gas emissions from vehicles.

Another project, supported by DOE, investigates the use of plasmatron generated hydrogen as a means to improve catalytic reduction of diesel engine exhaust pollutants. In addition, the Plasma Science and Fusion Center is investigating the use of plasma based devices for producing hydrogen for stationary fuel cells. This work is sponsored by Chevron Texaco.

The Plasma Technology Division is also researching and developing advanced diagnostic and monitoring systems for fusion energy research, environmental monitoring, and nuclear waste remediation. For fusion energy research, millimeter-wave collective Thomson scattering (CTS) diagnostics for fast ion measurements (see also under Physics Research Division, Experimental Research) are being developed in an international collaboration between MIT, Risø National Laboratory, Denmark, and two German laboratories. Energetic ions (alpha particles) are byproducts of fusion burn in a D-T plasma. It is essential that these ions remain confined and give up their energy to fusion reactions. Consequently, the physics of high-energy ions produced by auxiliary heating and by fusion reactions must be understood and controlled in order to progress to a practical source of power. The CTS development will provide a needed diagnostic tool enabling this progress. Experiments will be carried out on the German TEXTOR and ASDEX tokamaks, which have unique high power gyrotron facilities for providing the high power millimeter-waves needed for this research.

In the environmental monitoring area, the Plasma Technology Division is developing millimeter-wave pyrometry, reflectometry, and viscometry for online monitoring of nuclear waste vitrification process. The objectives of this technology development effort are to contribute to the DOE environmental management needs to speed up and reduce costs of the national effort to clean up nuclear waste sites. The new online monitoring technology will make possible maximizing glass waste loading, which will reduce waste volumes and speed up the processing time. This will result in large cost savings. The work to date has received important awards and recognition. An R&D 100 Award was earned in 2001 for the viscometry development as one of the most significant new technologies in that year. Also, a presentation given at the 2001 American Ceramics Society Meeting earned a best paper award for Nuclear and Environmental Technology Division. This work is also being highlighted as an Environmental Management Science Program (EMSP) success story at the American Nuclear Society 2002 Spectrum meeting.

Technology and Engineering Division

The Technology and Engineering (T&E) Division, headed by Dr. Joseph Minervini, conducts research on conventional and superconducting magnets for fusion devices and other large scale power and energy systems. The major emphasis of the division's effort continues to be on support of the US Fusion Program where the PSFC has the leadership responsibility for the Magnets Enabling Technology program. Long term reduced funding for fusion technology has been compensated in recent years by successful pursuit of increased funding from non-Office of Fusion Energy Sciences (OFES) sources. Under the OFES magnetics program, the major test program for the Central Solenoid Model Coil (CSMC) was completed at the Japanese Atomic Energy Research Institute (JAERI) in Naka, Japan. The CSMC, and other coils were fabricated as part of the International Thermonuclear Experimental Reactor (ITER) program when the US participated during the Engineering Design Activity. The PSFC had a major role in the design, construction and testing of the CSMC. This past year, the focus of the testing was on a Toroidal Field Insert Coil, designed and fabricated in Russia, and on an insert coil designed and fabricated in Japan using Nb3Al superconductor. PSFC personnel participated at the Naka site in the experimental test program in leadership positions. PSFC personnel also participated in the test of the Toroidal Field Model Coil (TFMC), fabricated in Europe and tested at the Forschungzentrum Karlsruhe (FzK) in Germany.

In August, the division will host the US-Japan Workshop at MIT on Superconducting Magnet Technology to discuss the test results, including analysis and supporting R&D associated with this recent series of major coil tests. Participants will include representatives from national laboratories and universities from Japan, Europe and Russia, as well as collaborating US laboratories and universities.The US DOE and the Administration are presently seriously considering rejoining the ITER collaboration. If this does occur, the division would expect to play a leading role in the development of magnet

technology for this very large scale device, and thus a substantial increase in funding. Meanwhile, further development of the superalloy Incoloy® Alloy 908 is being continued in the Technology and Engineering Divisions Materials Science Laboratory under the direction of Professor Ronald Ballinger.

The division provided engineering support to the Princeton Plasma Physics Laboratory in the evaluation of Next Step Options for the US Fusion Program and in the design of the Fusion Ignition Research Experiment (FIRE). MIT continues to play a lead role in the magnet system design, cryogenic system design, and structural design for the FIRE as well as systems level studies. At the recent OFES sponsored Snowmass Summer Study, Joseph Minervini was a co-convener of the Magnet Technology Working Sub-Group for evaluation of three options for a Burning Plasma Experiment.

Other areas of research by the division include:

—Quadrupole magnet array design studies for the Lawrence Berkeley National Laboratory's High Current Transport Experiment (HCX) and the Integrated Research Experiment (IRE).

—Fabrication of the magnet systems for the Levitated Dipole Experiment (LDX). The Levitation Coil (L-Coil) was completed and preliminary tests performed. This coil successfully demonstrated the first use in the US Fusion Program of a High Temperature Superconductor (HTS) material. The larger scale Charging Coil (C-Coil) fabrication neared completion under contract to the D.V. Efremov Institute-Sintez at St. Petersburg, Russia. Construction oversight of the manufacturing in Russia was done by division personnel.

— Completion of the Conceptual Design Report for the MECO Superconducting Magnet Systems. The division has greatly increased the diversity of its research portfolio with a significant increase in non-OFES funded work. The Muon-to-Electron Conversion Experiment (MECO) is part of the Rare Symmetry Violation Processes (RSVP) program. The project is funded by NSF through the University of California-Irvine. The experiment is to be installed at Brookhaven National Laboratory (BNL). The division also received funding from Brookhaven National Laboratory for the engineering design of a pulsed, cryogenic magnet for mercury jet targetry. This is part of the High Energy Physics program for a Muon Collider/ Neutrino Factory. The design will be completed later this fiscal year, and we expect fabrication and testing of the coil to be funded in FY2003.

—Design and development of proton radiography superconducting quadrupole focusing magnets for the Advanced Hydrodynamic Facility (AHF) being developed at the Los Alamos National Laboratory. This project is part of the US Nuclear Stockpile Stewardship program. More detailed design was performed this fiscal year on the large bore superconducting quadrupole magnets. We are expecting an expanded program in the next fiscal year with increased funding to begin prototype superconducting magnet development.

—Completion of work on a NASA-funded Phase-I STTR, in collaboration with the Advanced Magnet Laboratory, Inc., a Florida-based small business. The focus of the STTR was the design of a Superconducting Magnetic Energy Storage System (SMES) to power a "Maglifter," an electromagnetic catapult designed to lower the cost of cargo delivery to space. We also continued design of the superconducting levitation magnets for the Maglifter under a NASA Phase -II STTR. AML, Inc. is now beginning fabrication of the magnet system and we will test them at MIT when completed next year.

—Direct continuous magnetic separation of blood cells and plasma from whole blood. Dr. Makoto Takayasu was successful in receiving funding from NSF for a project to develop this process. Funding began in November 2001, with continuation expected for a second year into FY2003. The purpose of this grant is to demonstrate the advantages of a continuous, gentle separation method using no tagging agents. It may also be suitable for other types of cell separation applications.

Educational Outreach Programs

The Plasma Science and Fusion Center's educational outreach program is planned and organized under the direction of Mr. Paul Rivenberg, communications and outreach administrator. The program focuses on heightening the interest of K–12 students in scientific and technical subjects by bringing them together with scientists, engineers and graduate students in real laboratory and experimental environments. This kind of interaction often encourages young people to consider science and engineering careers. Tours of our facilities are also available for the general public. Annual visitors include Minority Introduction to Engineering, Science and Entrepreneurship Program (MITE2S), Keys to Empowering Youth (KEYS), and the National Youth Leadership Forum. Special "Outreach Days" are held twice a year, encouraging high school and middle school students from around Massachusetts to visit the PSFC for hands-on demonstrations and tours. Key to the success of our tour programs is the involvement of PSFC graduate students who volunteer to assist. The experience helps them understand how to communicate a complicated science to those who do not have an advanced science background.

The Mr. Magnet Program, headed by Mr. Paul Thomas, is completing its tenth year of bringing lively demonstrations on magnetism into local elementary and middle schools. This year Mr. Magnet presented the program to over 30,000 students at over 82 schools and other events,

reaching students from kindergarten through college freshmen. He makes a special effort to encourage girls to consider a science related career. In spring 2002 Paul Thomas traveled with his truckload of equipment to Washington, DC, at the request of the Department of Energy, to involve participants of the DOE National Science Bowl with his hands on magnetic experiences. He has recently expanded his teaching to include an interactive demonstration of plasma, encouraging participants to investigate plasma properties with audiovisual, electromagnetic, and spectroscopic techniques. He has also developed a workshop for middle schools on how to build an electromagnet. He is currently creating a new hands on plasma demonstration device similar to one he created for the MIT Museum to be stationed in the PSFC Headquarters area, allowing visitors and staff members a chance to examine plasma on their own. Mr. Thomas has also collaborated with the MIT Museum's Sunday science program, and is currently planning with them a series of winter talks inspired by Michael Faraday's Christmas lectures.

Mr. Thomas and Mr. Rivenberg were both recognized this year for their outreach efforts by Fusion Power Associates, a national organization devoted to informing the public about fusion development and applications of plasma science. They received special awards honoring their sustained efforts to educate students and the public about fusion and related technologies.

The PSFC continues to collaborate with other National laboratories on educational events. An annual Teacher's Day (to educate teachers about plasmas) and Open House (to which they can bring their students) has become tradition at each year's APS-DPP meeting. Mr. Rivenberg, Mr. Thomas and Ms. Valerie Censabella, Alcator Administrator, aided organizers of the 2001 education events in Long Beach, CA, which attracted about 100 teachers, and over 2000 students. Here the PSFC unveiled an improved version of the C-Mod, Jr. video game, which teaches students how to confine a plasma in a tokamak. Mr. Thomas also brought with him a new, more portable plasma demonstration device. The education team continues to work on similar events scheduled for Orlando, Florida (APS-DPP meeting, fall 2002).

The PSFC continues to be involved with educational efforts sponsored by the Coalition for Plasma Science (CPS), a growing organization formed by members of universities and national laboratories to promote understanding of the field of plasma science. Associate Director Dr. Richard Temkin, who oversees PSFC education efforts, is working with this group on goals which include requesting support from Congress and funding agencies, strengthening appreciation of the plasma sciences by obtaining endorsements from industries involved in plasma applications, and addressing environmental concerns about plasma science, particularly fusion. Paul Rivenberg has continued his duties as editor of the Coalition's Plasma Page, a summary of plasma related news items of interest to the media. Mr. Rivenberg also heads a subcommittee that created and maintains a web site to help teachers bring the topic of plasma into their classrooms. Paul has also joined the Technical Materials subcommittee, where he oversees content and layout of two-page information sheets that introduce the layman to different areas of plasma science. He is aided by Ms. Mary Pat McNally, who provides support for all graphic projects.

Appointments and Promotions

During the past year, there have been a number of appointments and promotions in Plasma Science and Fusion Center program areas:

Appointments

Alcator Division—Mr. Peter Koert was appointed an RF engineer and Mr. Michael DeMaria was appointed design engineer.

Physics Research Division—Dr. Ante Salcedo was appointed postdoctoral associate.

Fusion Engineering and Technology Division—Mr. Peter Titus was appointed senior mechanical engineer; Dr. Jun Feng was appointed research engineer; and Dr. Timothy Antaya was appointed senior project engineer.

Plasma Technology Division—Dr. Kamal Hadidi was appointed research scientist.

Internal Promotions

Physics Research Division—Dr. Johan Frenje was appointed research scientist.

Graduate Degrees

During the past year, the following departments granted students degrees with theses in plasma fusion and related areas:

- Nuclear Engineering: Bruno, Antonio, PhD
- Physics: Nelson-Melby, Eric, PhD; Hess, Mark, PhD; Lin, Y., PhD; Mazurenko, Alexander, PhD

Miklos Porkolab
Director
Professor of Physics

More information about the Plasma Science and Fusion Center can be found on the web at http://www.psfc.mit.edu/.

Research Laboratory of Electronics

The Research Laboratory of Electronics (RLE), founded in 1946, is the Institute's first interdisciplinary research laboratory. Today it is the largest such laboratory at MIT in terms of faculty and student participation. RLE grew out of the wartime MIT Radiation Laboratory and was formed to bring together physicists and electrical engineers to work on problems in electromagnetic radiation, circuits, and specialized vacuum tubes. Over the years, RLE's research interests have branched in many directions and have led to the creation of additional laboratories.

Research within RLE today is conducted by approximately 40 faculty members who are affiliated with the Departments of Electrical Engineering and Computer Science, Physics, Mechanical Engineering, Materials Science and Engineering, Aeronautics and Astronautics, and the Harvard-MIT Division of Health Sciences and Technology. During the past year, approximately 250 graduate students and 60 undergraduates from 11 MIT departments pursued research within RLE. The research is supported primarily by the Department of Defense (DoD) agencies; the Department of Energy (DOE); the National Science Foundation (NSF); the National Institutes of Health (NIH); and the National Aeronautics and Space Administration (NASA). In addition, numerous projects are funded through industry and private foundations.

RLE research is widely varied and consists of four major interrelated groupings: circuits, systems, and communications; physical sciences; quantum computation and communication; photonic materials, devices, and systems; and communication biophysics. Detailed information about RLE research in the calendar year 2001 can be found in RLE Progress Report No. 144, online at http://www.rle.mit.edu/Publications/prog.htm.We summarize in the present report research highlights during the past year.

Circuits, Systems, and Communications

Professor Jacob White has completed development of FastStokes, a fast 3D Stokes solver useful for computing drag forces in viscous flows. The program was used to compute drag forces on a complicated micromachined comb drive and a micromirror. It is the only simulation program fast enough to analyze such complicated three dimensional structures in a reasonable period of time, and so was the only approach able to accurately predict the amplitude of the comb drive and micromirror response at resonance, as verified by measurements.

Professor Alan Oppenheim has developed several new and innovative algorithms relating to efficient ways of implementing signal processing. Particular examples include his work on distributed signal processing, and the completion of a new, general approach known as quantum signal processing. Professor Oppenheim has also developed some new algorithms associated with randomized sampling strategies and with nonuniform sampling.

Professor Gregory Wornell directs the newly formed Center for Wireless Networking. His research focuses on algorithmic and architectural aspects of the design of multimedia content security systems, wireless communication and sensor networks, and reliable circuits and microsystems. During the past year, he has developed the fundamental limits and inherent tradeoffs for multimedia authentication, and the structure of robust digital signature systems that achieve these limits. In the area of wireless networks, he has developed a promising new system-level architecture for wireless local area networks that can support gigabit per second data rates in typical environments by exploiting advanced coding and signal processing algorithms in a multiple-antenna access point design.

Professor Jae Lim's Advanced Telecommunications and Signal Processing (ATSP) group participated in the design of the Grand Alliance digital High-Definition Television (HDTV) system, which served as the basis for the U.S. digital television standard adopted by the Federal Communications Commission. During the past year, Professor Lim has sought ways to migrate to a higher resolution digital television system using video enhancement bits. Preliminary results have been encouraging, and one of the approaches developed by the ATSP group has to potential to serve as the basis for a future standard.

Professor David Staelin and Dr. Philip Rosenkranz have continued their work on the development of instruments and algorithms for retrieving atmospheric and surface parameters from data collected by airborne or satellite sensors. They are members of the science team that is studying microwave and hyperspectral imagery of the atmosphere using data from the NASA's recently launched Aqua satellite. Also, during the past year, they have completed construction and flight testing on high-altitude aircraft of a 183-GHz 6-channel imaging spectrometer that complements the existing RLE 54- and 118-GHz imaging spectrometer aircraft instruments, which support NOAA and NASA in remote sensing of weather systems. In addition, Professor Staelin made significant improvements to algorithms that use these microwave satellite assets to image quantitatively the global rain rates and snowfall, offering a potentially important new tool for operational monitoring of the global water balance.

Professor Rahul Sarpeshkar is pursuing a collection of projects in biologically inspired electronics. His low power bionic ear project involves designing an ultra low power analog cochlear implant processor whose performance will

exceed that of digital processors by more than an order of magnitude. During the past year, Professor Sarpeshkar completed work on the ultra low power programmable bandpass filter for use in the bionic ear. In his project on time-based hybrid computing, Professor Sarpeshkar is combining the best of analog and digital architectures to compute more efficiently than would be possible in either paradigm alone.

Professor John Wyatt is working on a retinal implant device to restore some level of useful vision to patients with outer retinal diseases. During the past year he has designed a low power stimulation circuit for use in this implant. He has also microfabricated a new retinal attachment device. Both of these results may be of use in more general neural implant devices.

Professor Donald Troxel is working on the design of three-dimensional integrated circuits (3D ICs). In particular, he has developed a comprehensive layout methodology for bonded 3D ICs, in which parts of a circuit are fabricated on different wafers, and then the wafers are bonded with a glue layer of Cu or polymer-based adhesive. Using his methodology, designers can, for the first time, layout such 3D circuits with necessary information on inter-wafer via/contact and the orientation of each wafer embedded in the layout.

Professor Dennis Freeman has developed an optical projector that coherently combines light from a discrete set of laser beams to produce a "needle" of light, i.e., a light pattern that has high spatial resolution in the lateral direction and large axial depth of field. In other structured illumination work, Professor Freeman has demonstrated resolution-enhanced microscopy, by reconstructing an image of a constellation of microparticles that could not be resolved with uniform illumination.

Physical Sciences

Professors Daniel Kleppner and Thomas Greytak are continuing their studies of ultracold hydrogen. During the past year, they completed an experimental study of the growth dynamics of a Bose-Einstein condensate of hydrogen, and found good agreement with a recent theoretical analysis. They also studied collisions between ultracold metastable hydrogen atoms, and obtained the first observations of the collision rate between these atoms. The results were in reasonable agreement with new, and somewhat surprising, theoretical predictions. Work was undertaken on the trapping of ultracold deuterium, and a new program on ultraprecise spectroscopy of hydrogen was initiated.

Professor David Pritchard has demonstrated a new type of matter-wave interferometer, called the contrast interferometer, that is insensitive to many of the systematic effects that have plagued other atom interferometry experiments. It works by encoding the desired signal in the contrast of the interference pattern, while leaving much of the noise in the phase of the interference pattern, which is not measured. In his experiment, the photon-recoil frequency of sodium was measured with a statistical error of 15 parts per million. The recoil frequency is due to the kinetic energy imprinted on an atom by the scattering of a single photon. Precision measurements of this frequency can be combined with other recent measurements to give a new independent route to the determination of the fine-structure constant.

Professor Wolfgang Ketterle's research concentrates on the properties of Bose-Einstein condensates and Fermi seas. Such quantum degenerate gases are novel systems in which to study many body physics, including phase transitions, superfluidity, and vortices. During the past year, he has extended experimental methods of laser and evaporative cooling to realize quantum degeneracy in trapped Fermi gases, thus providing a rich, new system to explore the implications of Pauli exclusion on scattering properties and, ultimately, fermionic superfluidity. Professor Ketterle has also made substantial progress in coherent manipulation of matter-wave sources. In particular, he has demonstrated that a gaseous Bose-Einstein condensate can be transported with optical tweezers and then transferred into a magnetic trap that was microfabricated on a silicon substrate. Finally, he was the first to produce a continuous source of Bose-Einstein condensed atoms, by periodically replenishing a condensate held in an optical dipole trap with new condensates thereby continuously maintaining a condensate of more than 106 atoms.

Professor John Joannopoulos has been working on an ab-initio exploration of the energetics of bistability in Si dimers on the Si (100) surface and their potential use as elements to form logic gates. Device miniaturization—the focus of modern seminconductor-based computer technology—is approaching its downscaling limit, and alternative paradigms employing nano-scale components are being sought. Professor Joannopoulos's research is aimed at systems that self-assemble into logic gates. His calculations predict that a Tungsten scanning probe can mediate the interactions between bistable Si (100) surface dimers. Interpreting the state of each dimer as a bit of information, his calculations then demonstrated the use of this mediated interaction to construct a NOR logic gate.

Professor Abraham Bers made significant progress in three areas of plasma electrodynamics. He has used general properties of wave energy-flow conservation and time reversibility to derive symmetry properties of linear mode conversion. Simulated Raman scattering (SRS) that induces Langmuir decay interactions (LDI) was explored in both theoretical and experimental work. Finally, in collaboration with Dr. Yves Peysson of the Commissariat à l'Énergie Atomique, Professor Bers developed an improved code for

studying the self-consistent generation of RF current drive and bootstrap current, currents of importance for steady-state tokomak operation.

Professor Bruno Coppi continued to make progress in his investigations of the physics of high energy plasmas. His work addressed a broad spectrum of subjects related to the large class of plasmas dominated by collective modes rather than by collisional processes. These efforts included work in the basic physics of fusion burning plasmas, the design of fusion burning experiments, advances in computational physics and theory related to the excitation of macroscopic modes in magnetically-confined plasmas, and the determination of modes than can provide the outward transport of angular momentum in accretion disks.

Dr. Linda Sugiyama is continuing her development of a large-scale simulation code for magnetically confined plasmas. The major achievement of the past year was the full implementation of a two fluid plasma model (electron and ion fluids) in the formerly single-fluid code M3D. M3D runs on massively parallel machines, and can handle most varieties of confined plasma configurations. The new code was used to study magnetic reconnection in different plasma configurations.

Professor Jin Kong's research on electromagnetics has concentrated on three essential activities: left handed media, unexploded ordnance (UXO) detection, and remote sensing of vegetation. His work on left handed media includes both theory and numerical simulations related to media exhibiting a negative index of refraction. In UXO detection studies, he has initiated a combined approach using finite elements and integral equations. In vegetation sensing, he has carried out polarimetric studies of forests in Japan, in order to estimate forest density from synthetic aperture radar (SAR) imagery.

Quantum Computation and Communication

Professor Seth Lloyd works on building and operating quantum computers and quantum communication systems. Major accomplishments during the past year include: development of a new quantum computer architecture using ground state quantum computation; a theoretical demonstration that quantum effects such as entanglement could be used to enhance the accuracy of positioning, radar, and clock synchronization systems; and the first quantum computations showing quantum chaos on a quantum computer. In addition, Professor Lloyd has shown how quantum information processing could provide a significant increase in the capacity of power limited quantum communication channels.

Professor Jeffrey Shapiro and Dr. Franco Wong have been working on the generation of entangled photons and their applications in quantum communications and quantum cryptography. During the past year, they demonstrated high flux sources of wavelength-tunable entangled photons generated by optical parametric downconversion in periodically poled nonlinear crystals. They also extended previous theoretical work on intracavity entanglement generation, revealing existence of coincidence dips and revivals. In work on quantum communication architecture, they developed error models for long distance teleportation architecture, whose technology elements are being developed at MIT and Northwestern University, and have shown how quantum error correction and/or entanglement purification protocols can improve the performance of this architecture. In classical-domain optical communications they have established a test bed for through the air laser communications, and have developed theoretical results for spatial diversity reception, space-time coding, and channel capacity for the turbulent atmospheric channel.

Professor Terry Orlando is using superconducting circuits as components for quantum computing and as model systems for nonlinear dynamics. The goal of the present research is to use superconducting quantum circuits to perform the measurement process, to model the sources of decoherence, and to develop scalable algorithms. The particular device being studied is made from a loop of niobium interrupted by 3-nm-size Josephson junctions. Professor Orlando has successfully demonstrated that the niobium qubit has low enough dissipation to behave quantum mechanically.

Dr. Selim Shahriar has, for the first time, demonstrated the slowing and eventual stopping of light in a solid. This has many potential applications, including teleportation of the quantum state of a macroscopic crystal. He has also designed, and demonstrated the feasibility of, a super-parallel holographic optical correlator that is capable of searching through 1 terabyte of data, encoded in 10 million images, in 1 msec. This correlator may find commercial applications in face recognition, fingerprint identification, and video data mining.

Photonic Materials, Devices, and Systems

Professor Leslie Kolodziejski and Dr. Gale Petrich are working on the fabrication of opto-electronic devices composed of III-V compound semiconductors. Their principal research activities for the past year include: development of a feedback system for the controlled deposition of III-V epilayers using a molecular beam epitaxy (MBE) system in conjunction with a spectroscopic ellipsometer; the development of InP-based and GaAs-based bipolar cascade lasers; the development of a variety of high index contrast, photonic crystal devices; and the use of electro-mechanical motion to modify optical device behavior. A particular achievement of note was the significant improvement in the extraction efficiency

of photo-pumped light emitting diodes by inclusion of a photonic crystal within the active region.

Professor Henry Smith directs the NanosStructures Laboratory (NSL), whose dual mission is the development of advanced nanofabrication technology and the application of that technology to research in optical, electronic, and magnetic devices. Research highlights from the past year include the demonstration of 17-nm minimum linewidths in a new scanning-electron-beam lithography system that, together with nanometer-level placement accuracy, is a major step forward in MIT's unique capabilities in nanotechnology. Another significant achievement, done in collaboration with Professor Moungi Bawendi, was a distributed-feedback laser based on nanoparticles that used gratings fabricated via interference lithography. Professor Smith has invented a new way to fabricate 3D photonic crystals, and is seeking a patent on this approach. This technique could enable the promise of photonic bandgap structures to be finally realized in a practical configuration.

Professor Yoel Fink has completed the construction of a state of the art fiber-optic fabrication facility. With this facility, he has unique infrastructure—from glass synthesis, through fiber draw tower, to optical characterization—for the development of photonic bandgap optical fibers. He has fabricated the world's first high index contrast cylindrical photonic bandgap fibers in two different configurations. The first uses dielectric layers on the outer circumference to form a highly reflective, "perfect mirror" fiber. The second has its dielectric layers surrounding a hollow core to provide a guiding structure for optical or quantum communications, called "Omniguide" fiber. Optical characterization has shown that the mirror fiber has reflectivity comparable to that of the best metal reflectors. CO2 laser transmission measurements through extended lengths of Omniguide fiber have shown low loss.

Professor Erich Ippen continues to develop the technology of ultrashort-pulse (femtosecond) lasers and to use these new sources in scientific and engineering applications. During the past year, he demonstrated quantum-limited timing jitter in high-repetition-rate picosecond pulse trains from both a fiber soliton laser and a modelocked semiconductor laser, confirming theoretical work done in collaboration with Professor Hermann Haus. Together with Professor Franz Kärtner, Professor Ippen has obtained the shortest pulses ever, less than 20 fs in duration, from a Cr4+:YAG laser. This laser employed photonic bandgap mirrors, for self-starting operation, grown by Professor Kolodziejski's group.

Professor Franz Kärtner is developing few-cycle laser sources for use in fundamental studies in nonlinear optics, frequency metrology, and optical imaging. In cooperation with Professor Wegener of the University of Karlsruhe, he has discovered carrier-wave Rabi-flopping in GaAs and extreme nonlinear optics in solids. He has also demonstrated a nonlinear Fabry-Perot resonator as an intracavity modulator for active laser modelocking and synchronization, and, together with Professor James Fujimoto, has developed a record bandwidth, prismless Ti:Sapphire laser and a low threshold Ti:Sapphire laser. The prismless Ti:Sapphire source has applications both in frequency metrology and high resolution optical coherence tomography. The low threshold Ti:Sapphire laser may lead to a femtosecond laser whose cost is a third of that of currently available technology.

Professor James Fujimoto divides his research efforts between two areas: laser medicine and diagnostics; and ultrashort-pulse laser technology. He continues to pioneer optical coherence tomography (OCT), a field which was created by his group in 1990. OCT is an emerging medical imaging technology that is analogous to ultrasound. In recent work, Professor Fujimoto has improved the image resolution of OCT from 10-15 μm to approximately 1 μm, and performed the first studies of ultrahigh resolution imaging in ophthalmology. Clinical imaging studies are now beginning in collaboration with investigators from the New England Eye Center. In addition to his work on new ultrashort-pulse lasers, cited above, Professor Fujimoto has begun studies of photonic device fabrication using ultrashort pulses. He has demonstrated the fabrication of single mode waveguides in glass as well as couplers and Mach-Zehnder interferometers. These techniques permit 3D waveguide structures to be fabricated, increasing the density of fabrication compared to planar structures.

Professor Vladimir Bulovic studies the physical properties of organic thin films, structures and devices. During the past year, he developed a hybrid organic/inorganic heterostructured light emitting device that utilizes a single monolayer of self-assembled CdSe quantum dots as emissive centers. These devices surpass the efficiency of earlier quantum dot light-emitting diodes (LEDs) by a factor of 25 and, for the first time, demonstrate that quantum-dot-LED technology can reach the efficiencies necessary for commercial applications. In other work, Professor Bulovic developed a theoretical framework to explain the solid-state solvation effect that can produce energy level shifts in most organic materials, tuning the bandgap energy by as much as 0.3 eV.

Professor Rajeev Ram addresses the science questions that arise during the development of new opto-electronic devices, as well as issues of electron hydrodynamics, quantum transport, and micromagnetics. Research recent highlights include the development of two new semiconductor lasers that incorporate novel electron transport: bipolar cascade lasers and internally cooled semiconductor lasers. Bipolar cascade lasers utilize Esaki junctions to couple multiple active layers, leading to significantly higher differential efficiency and signal-to-

noise ratio than for conventional semiconductor lasers. Work on internally cooled lasers has led to the development of the first theory for thermoelectric effects in bipolar devices under forward bias.

Professor Qing Hu's research is focused on the development of terahertz sources, detectors, and systems. During the past year, he has observed very narrow linewidth (approximately 0.7 meV) intersubband emission at 5 THz, and established coherent coupling between subband levels using magneto-tunneling spectroscopy. He has also designed an optically pumped intersubband THz laser structure, and a high-frequency HBT that uses phonon enhanced base transport.

Professor Peter Hagelstein has measured high efficiency for the conversion of thermal to electrical energy in a novel device that he has termed the "thermal diode." The basic structure consists primarily of a slab of near intrinsic thermoelectric semiconductor, with a thin moderately-doped emitter layer on the hot side. This layer injects a current into the semiconductor thermoelectric in the presence of a temperature gradient, greatly enhancing the conversion efficiency. This effect, which appears to be new, is attributed to a second-order thermionic effect. Experiments carried out at Eneco have yielded conversion efficiencies on the order of 40 percent of the Carnot limit for an n-type segment.

Communication Biophysics

Professor Kenneth Stevens is developing a set of principles that govern the variability observed in the acoustic patterns for words in continuous speech. Knowledge of these principles is leading to the formulation of models for the process by which human listeners identify words in running speech in spite of this variability. He is also engaged in basic studies of the aerodynamic, mechanical, acoustic, and perceptual processes involved in the generation of speech.

Dr. Stefanie Shattuck-Hufnagel studies the prosody of spoken language, both in the sense of the abstract structures that specify the prosody of a spoken utterance—e.g., intonational—in the sense of how those structures are reflected in the phonetic variation of word forms across different utterances. She has recently begun a new line of research, testing the hypothesis that speakers coordinate the gestures they make during speech with the prosodic structure of their utterances, e.g., by timing the end points of gestures to co-occur with pitch accented syllables.

Professor Louis Braida and Dr. Julie Greenberg are trying to predict the intelligibility of cochlear implant processed speech and to develop a subject-independent metric that can be used to predict the maximum possible intelligibility performance for particular cochlear implant speech processing strategies. During the past year, they have completed detailed analyses of several proposed metrics from the literature and begun to perform speech intelligibility experiments with human subjects.

Dr. Andrew Oxenham is addressing fundamental questions in pitch perception. Using stimuli that transpose information normally available at low frequencies into high frequency regions, he has discovered that the auditory system cannot use timing information alone to accurately extract pitch. This may be the first evidence that veridical place information is necessary for pitch perception. The results have important implications for models of auditory processing, as many modern models discard the place information at an early stage.

Professor Dennis Freeman made further advances in his work investigating cochlear mechanics to understand how inner ear mechanisms determine the neural code that relates sounds to nerve messages that enter the brain. During the past year, he has taken three dimensional images of the tectorial membrane as a function of time to measure tectorial membrane volume in fluids with various polyethylene glycol concentrations. In addition, an in vitro preparation for studying cochlear micromechanics was developed. By using stroboscopic illumination and the optical sectioning property of a light microscope, slow motion, three dimensional images of micromechanical structures during sound stimulation were obtained.

Dr. Mandayam Srinivasan directs the Touch Lab, whose research focus is haptics, viz., information acquisition and object manipulation through touch by humans and/or machines in real, virtual, or teleoperated environments. During the past year, he has made significant progress in studies of the biomechanics of skin, the development of virtual reality based surgical simulators, the development of a multi-user shared virtual environment with graphics and haptics (in collaboration with Professor Mel Slater of University College, London), and brain-machine interfaces (in collaboration with Professor Miguel Nicolelis of Duke University). In his "Touch Across the Atlantic" project, individual users at University College, London and MIT were able to manipulate virtual objects in real time in a collaborative manner, while simultaneously seeing the objects on their monitors and feeling each other's forces on the tool held in their hand.

Dr. Joseph Perkell has launched a four year project to study the effects of hearing status on adult speech production. Together with his collaborators from the University of Miami, he has been gathering large amounts of acoustic and perceptual data from patients both prior to and following the introduction of hearing with a cochlear implant. Preliminary results support the hypothesis that hearing enhances a speaker's ability to adapt to perturbations that are introduced to the vocal tract. In the long run, these studies could have applications to methods for diagnosing and treating communication disorders.

Dr. Bertrand Delgutte has been working to understand the relative perceptual importance of the slowly varying temporal envelope of sounds versus their rapidly varying fine time structure. Together with Dr. Oxenham, he has created novel chimeric sounds that combine the temporal envelope of one sound with the fine structure of another. Experiments with these sounds have shown that speech reception depends primarily on the envelope, whereas melody recognition and sound localization rely on the fine structure. This finding suggests that modifying cochlear implants processors to deliver fine structure information would improve music appreciation, and, for patients implanted in both ears, speech reception in noise.

Dr. Donald Eddington's research is directed at a number of issues related to cochlear implants. Based on last year's work, which demonstrated that electrode interaction adversely affects speech recognition, Dr. Eddington developed and tested a novel stimulus waveform to reduce this interaction by as much as 80 percent. He then designed sound-processing strategies that employed this waveform and found that some patients improved their scores on consonant or vowel reception tests by 25 percent when the new strategies were used.

Dr. George Zweig continued his work to creating novel adaptive transforms of acoustic signals that qualitatively improve the identification of sounds in noisy environments. Such transforms can be implemented in low power analog VLSI circuitry for sound preprocessing in microelectromechanical systems (MEMS). During the past year, Dr. Zweig established the connection between transforms based on convolutions, like the waveform of the cochlea, and solutions of certain partial differential equations. Methods for inverting those transforms were developed, so that those transforms, when thresholded, can be used to remove noise from sounds.

Appointments and Awards

Professor Jacob K. White was appointed associate director. Joseph C. Connolly's title was changed to assistant director for administration. William H. Smith, III was promoted to assistant director for finance and sponsor relations. David W. Foss's title was changed to manager of information systems and networking. Mary E. Young was promoted to senior fiscal officer. Rosaria M. Rizzo was promoted to fiscal officer. Maureen C. Howard was promoted to personnel staff assistant. Maxine P. Samuels was promoted to financial staff assistant (Purchasing). Lorraine J. Simmons was promoted to financial staff assistant (Accounting). Krista Van Guilder was appointed to the position of media specialist. Professor Franz X. Kärtner was appointed associate professor of electrical engineering and computer science with permanent tenure. Dr. Yoel Fink was appointed assistant professor of materials science and engineering. Marc Baldo was appointed assistant professor of electrical engineering and computer science. Professor David E. Pritchard was appointed the Cecil and Ida Green professor of physics. Professor Qing Hu was promoted to full professor, effective 1 July 2002. Professor Seth Lloyd was promoted to full professor, effective 1 July 2002. Professor Gregory W. Wornell was promoted to full professor, effective 1 July 2002. Professor Dennis M. Freeman received permanent tenure, effective 1 July 2002.

Professor Wolfgang Ketterle shared the 2001 Nobel Prize in Physics. Professor Daniel Kleppner was selected by the National Academy of Sciences to give the 2002 Robertson Memorial Lecture. Professor James G. Fujimoto was elected a Fellow of the American Academy of Arts and Sciences, and shared the 2002 Rank Prize for Opto-Electronics. Professor Rajeev Ram received the Ruth and Joel Spira Award for Excellence in Teaching. Professor Rahul Sarpeshkar received a David and Lucille Packard Foundation Fellowship and an Office of Naval Research (ONR) Young Investigator Award. Dr. Andrew Oxenham was awarded the R. Bruce Lindsay Award by the Acoustical Society of America. William H. Smith; III, Albert T. McGurl, and Carol A. Costa received 2002 MIT Infinite Miles Awards.

Affirmative Action

RLE has worked and will continue working to increase the number of women and minorities in career positions in the laboratory, in the context of the limited pool of qualified technical applicants and the unique qualifications of RLE's sponsored research staff. Specific measures will include: maintaining our high standards for recruitment procedures that include sending job postings to minority colleges and organizations; working closely with the RLE faculty/staff supervisor at the beginning of each search to identify ways of recruiting minority and women candidates for the new position; and being committed to finding new techniques to identify more effectively women and minority candidates. During the past year significant progress has been made, in this regard, within RLE Headquarters. In particular, two women on RLE's administrative staff received promotions; three women (two of them underrepresented minorities) were promoted from support staff to administrative staff positions; and a woman was appointed to the newly created position of media specialist. However, due to limited turnover in RLE's research staff, success in affirmative action for research staff has been limited. Two research staff appointments were made during the past year; both were to women.

Jeffrey H. Shapiro
Director
Julius A. Stratton Professor of Electrical Engineering

More information about the Research Laboratory of Electronics can be found at http://www.rle.mit.edu/.

Sea Grant College Program

The MIT Sea Grant College Program provides funds for research, education, and technology transfer directed toward wise utilization of marine resources. MIT has been a leading participant in the national program since 1969. In 1976 the Institute was designated a Sea Grant College Program. Sea Grant College status offers the potential for greater funding and confers a responsibility to work with marine researchers throughout the Commonwealth.

Funds are distributed among the 30 Sea Grant Programs in a competing grant process by the National Oceanic and Atmospheric Administration through its National Office of Sea Grant. Each program is required to match every two dollars of its federal grant with one from non-federal sources. Congress established this matching provision to ensure that Sea Grant universities would be responsive to public and industry needs. Sea Grant provides funds explicitly for technology transfer through its mandate for advisory services and education in addition to its research mandate.

In FY2002 the National Office of Sea Grant awarded MIT over $2.5 million. Additionally MIT, industry partners, the Commonwealth, and other federal agencies provided more than $1.8 million. In all, these funds provided partial support for faculty and students from MIT's Departments of Civil and Environmental, and Ocean Engineering, and the Department of Science, Technology and Society, as well as partial support for faculty, staff and students at UMASS/Amherst, UMASS/Dartmouth, UMASS/Boston, UMASS/Lowell, Boston University, Harvard University, Northeastern University, Temple University, Smith College, Tufts School of Medicine, Massachusetts Maritime Academy, Woods Hole Oceanographic Institution (WHOI), the New England Aquarium, and the Boston, Quincy, and Cohasset Public Schools.

Core Research

Research at MIT Sea Grant is guided by the unique intellectual resources of colleges and universities in the commonwealth and by the needs of the marine community. Our research is divided into two categories. The first category is our core research program, which reflects the ongoing MIT Sea Grant (MITSG) management process and the guidance provided by our two advisory bodies: the State Advisory Council and the Faculty Committee. Within the core research area, we have four theme areas, with quite specific concentrations: marine biotechnology; coastal management and utilization; coupled ocean observation and modeling; and technology development and management for ocean uses. The second research category is our focused research, intended to address major regional and/or national issues or needs. Projects under focused research are also called Marine Center projects. We continue to build upon advances made in these areas and have been able to compete successfully for other grants as a result.

Marine Biotechnology

Sea Grant's research objective in marine biotechnology is the advancement of technology that can contribute to better use of the biological resources of ocean and coastal ecosystems. Recently completed research has included studies of novel delivery systems for the vaccination of farmed fish and novel and potentially important research in seaweed as a source of compounds having commercial potential in food processing and pharmaceuticals.

Our annual solicitation in 1999 for new proposals resulted in a new research project in Marine Biotechnology, "Production of High Value Food Proteins from Low Value Underutilized Fish," submitted by Professor Herb Hultin of UMASS/Amherst. This project began in March of 2000 and reached its completion in February of 2002.

A new research project in this theme area began in March of this year. "Novel Biomaterials with Potential Antibacterial and Adhesive/structural Properties from Ascidians (tunicates)," a two year research program, was submitted by Professor Manickam Sugumaran of University of Massachusetts/Boston.

Coastal Management and Utilization

Research projects within the coastal management and utilization theme area seek to advance the science and engineering needed to more effectively utilize our coastal and ocean resources and, either as an integral component or separately, increase our understanding of the marine ecosystem and our ability to influence its sustainability.

Two projects in coastal management and utilization, "Combined Wave-Current Flows Over a Movable Rippled Bed" led by Professor Ole Madsen of the Department of Civil and Environmental Engineering at MIT, and "Quantitative PCR Combined with Constant Denaturant Capillary Electrophoresis for the Analysis of Naturally Occurring Pathogens in Coastal Environments" with Professor Martin Polz of the Department of Civil and Environmental Engineering at MIT as the principal investigator, were completed in February of 2002.

Professor Robert Chen, Environmental, Coastal and Ocean Sciences at the University of Massachusetts/Boston, in collaboration with Professor Ana Soto of the Anatomy and Cellular Biology Department at Tufts School of Medicine continue in the second year of their research. Their proposal, "Identification of Endocrine Disrupters in Coastal Waters," represents timely research intended to establish sources and distributions of estrogen, and androgen activity in Boston Harbor.

Also in the second year of a two-year project is Dr. Michael Tlusty of the New England Aquarium. His proposal "Environmental Impacts of Lobster Pounds: Monitoring Impacts, Modeling Holding Capacity and Assessing Policy"

concerns the annual and long-term accumulation of organic matter in lobster pounds, and the modeling of the loading and fate of wastes in these pounds.

Two new research projects in this theme area began in March of 2002. "Modeling Copper Complextion in Coastal Waters" submitted by Professor Bettina Voelker of the Civil and Environmental Engineering (CEE) Department at MIT is funded as a two-year project and "New Passive Samples (PEDs) for Assessing Bioaccumulation of Organic Substances from Contaminated Sediments and Overlying Seawater," led by Professor Philip Gschwend, also of CEE, will be funded for a single year.

Coupled Ocean Observation and Modeling

Our annual call (issued in February of each year) for new research and outreach proposals to begin in March of 1999 included a new theme area, coupled ocean observation and modeling, as the newest theme area in our core program.

In our solicitation for new research to begin in March of 2000 there were two additions in the coupled ocean observation and modeling theme area—both of which have reached completion in February of 2002. "Acoustic Sensing of Sediment Properties Using a WWW-Controlled Shallow Water Mooring," led by Professor Henrik Schmidt of the Ocean Engineering Department at MIT, combined the Poseidon distributed oceanographic information system (refer to the focused research/marine centers section for a description of Poseidon) with a new instrumentation mooring for littoral environments to provide a unique facility for remote small-scale sensing capabilities for sediment characterization.

The second just completed project in this thematic area represented an interesting melding of two separate activities—one being the continuing development of AUV technology and its applications; the other being the relatively new efforts to incorporate what we have developed as an Autonomous Surface Craft (ASC) for similar ocean related work. This proposal, "Autonomous Underwater Vehicle Navigation and Control Using an Autonomous Surface Craft," originally proposed and led by Dr. James Bellingham, principal research engineer, was completed under the direction of Professor Schmidt.

AUV Laboratory

During the July 1, 2001–June 30, 2002 period the AUV Lab continued its aggressive schedule of field programs in support of its research agenda. The later half of 2001 was dedicated to the development of a new core software suite for all the autonomous vehicles operated by Sea Grant and the Department of Ocean Engineering. This Mission Oriented Operating System (MOOS) is a powerful new tool for marine robotics research. The first preliminary trials of MOOS in the Charles River were conducted in October of 2001. The focus of the winter months was in arranging the delivery of a new AUV from Bluefin Robotics Corporation. By late February the vehicle was in house and equipped with the new software. Dubbed Caribou (a tribute to its MOOS lineage) the Odyssey III class vehicle was ready for trials.

In March the lab took advantage of the hospitality of RPM Nautical (a non-profit marine archaeology organization) in Key West, Florida. Caribou, and its older Odyssey IId ancestor Xanthos, were dispatched to Florida for 10 days of aggressive sea trials. These were a great success and MOOS was deemed mature enough for use in following scientific deployments. Other notable achievements during this cruise included the preliminary development of advanced navigation filters for the AUVs and the regular use of acoustic modem telemetry to monitor vehicle status.

Following the success in Florida the AUV Lab was prepared to support Ocean Engineering Professors Schmidt and Leonard in the third Generic Oceanographic Array Technology Sonar (GOATS) experiment. As in late 2000 two MIT AUVs were dispatched to participate in the joint research effort with the NATO SACLANT Undersea Research Centre in La Spezia Italy. Caribou, Xanthos and the MIT AUV operations team joined the faculty, graduate students and colleagues from Woods Hole on the R/V Alliance and successfully completed the experiment. New methods of acoustically imaging objects on and under the seafloor were tested. Advanced navigation techniques provided accurate location of targets and adaptive sampling and supervisory control techniques were developed.

Following the GOATS experiment in late May and early June the AUV Lab took a short time off before proceeding to the next expedition, also in Italy. July 3rd–14th saw the lab team, with a series of partners, perform archaeological remote sensing in the Arcipelago Toscano. The Italian Navy provided two vessels for the expedition, which also benefited from the archaeological expertise of the American Academy in Rome, Pamela Gambogi—Soprintendenza Archeologica per la Toscana and the Ministero dei Beni e Attività Culturali. Technical partners from the Universities of Genoa and Pisa brought a Remotely Operated Vehicle (ROV) to the expedition. Together, this interdisciplinary team, explored the waters off Tuscany for ancient shipwrecks. Known wrecks were carefully resurveyed and some new wrecks were discovered. The AUV Lab learned valuable lessons about the application of AUVs in marine archaeology and plans to develop an entirely new vehicle well suited to this mission.

The MIT AUV Lab continues to host numerous UROP students and currently provides facilities and guidance for five graduate students (Courses XIII and II).

Technology Development and Management for Ocean Uses

Lastly is a theme area we have traditionally included in our proposal solicitation that is deliberately broad in focus and title—technology development and management for ocean uses. This theme area is meant to serve as an avenue for new and exciting ideas, and has, on occasion, yielded successful proposals that have evolved into continuing research theme areas.

Completed in February of this year was a project lead by Professor Michael Triantafyllou of Ocean Engineering. "Robotic Virtual Simulation Platform for Ship Maneuvering and Control," continues to advance our understanding of what it takes to function in the ocean realm and the opportunities in robotic systems for ocean adaptability. The objectives of Professor Triantafyllou's most recent research in this area are to improve the maneuvering capability and marine safety of conventional merchant and naval ships by providing a robotic virtual testing platform—a combined simulation and experimental platform that can simulate realistically any prescribed unsteady ship motion, and test the effectiveness of novel control schemes.

In our solicitation for new research in this theme area for projects to start in 2001 there were three successful proposals—all of which support and enhance the overall AUV program.

Professor John Leonard of the Ocean Engineering Department at MIT submitted a proposal to expand the autonomous navigation capabilities of the AUV. His proposal, "In-water Validation of Concurrent Mapping and Localization Using Sonar," pursues the in-water validation and performance analysis of a new algorithm for feature-based navigation of autonomous underwater vehicles using sonar.

Professor David A. Mindell, Program in Science, Technology and Society at MIT, submitted a proposal that will apply autonomous robotic systems to an as yet untried task. His project, "Precision Sub-bottom Profiling for Deep Water Archaeology," has as its focus developing technology to collect high-resolution volumetric data below the sea floor for local areas such as shipwrecks, waste sites, or construction areas.

Lastly, Professor Harold F. Hemond of the Department of Civil and Environmental Engineering at MIT submitted "Deployment of an Odyssey AUV Compatible In-Situ Mass Spectrometer." Hemond proposes to field a membrane inlet mass spectrometer (MIMS) capable of operating autonomously, or on board an Odyssey class autonomous underwater vehicle (AUV) and providing the vehicle with a powerful new suite of measurement capabilities. The new instrument will be capable of real-time, in-situ, high-resolution measurement of dissolved gases and volatile organic compounds in the marine environment. The immediate objective of this project is a successful underwater demonstration of the functioning instrument packaged in a pressure sphere and compatible as an Odyssey payload.

These three new projects will reach completion in February 2003.

Two new research projects in this theme area began in March of this year. "A Lorentz Force Actuator for Skin Friction and Noise reduction in Turbulent Flows Past AUVs," submitted by Professor George Karniadakis of Ocean Engineering, continues efforts to incorporate fundamental physics principles into solving flow and maneuvering limitations of manned and unmanned aquatic hull forms.

Dr. Milica Stojanovic, who joined the MIT Sea Grant College Program scientific team this past year, submitted a proposal to address another one of the limitations of unmanned subsurface vehicles. "High Rate Communication Link for Video Transmission from Autonomous Underwater Vehicle" will focus on developing the messaging protocols of a network of subsurface and surface system elements for high data rate communication.

Completion of these two projects is scheduled for February 2004.

Focused Research/Marine Centers

The objective of the focused research/marine center concept is to plan and conduct research programs in collaboration with, and jointly sponsored by, industry and government agencies in order to attack major problems of broad interest to the marine community, and to foster industrial competitiveness by transferring the resulting technology to users. Focused research projects have a six-year duration with the initial years heavily supported by Sea Grant Program funds. By the end of these multi-year projects the funding is expected to come entirely from non-Sea Grant sources.

As a consequence of the success of the focused research programs that addressed AUV technologies and applications we have been able to capture additional funding. This illustrates the intent of our Focused Research theme area and further demonstrates how early funding of well thought out research areas can establish the soundness of more specific research and development objectives.

On August 1, 1996 the initial, first year work began on the fourth focused research/marine center, "Behavior of Capped Contaminated Sediments," under the leadership of senior research associate, Dr. E. Eric Adams of MIT. This research is intended to address theoretical analysis and field studies to determine the processes occurring in a capped contaminated sediment site. This project was completed in July of 2002.

A more recent focused research/marine center, "Poseidon: A Coastal Zone Management System via the World Wide Web," initiated work in March of 1998. This project is a consequence of the high availability of raw ocean data, the various modeling approaches one can apply to large, multi-parameter data sets, and extensive uses such data derived knowledge make possible (weather forecasting, fisheries management, environmental impacts, etc.). Completion is scheduled for February of 2004.

The following year (1999) we again included the opportunity for new focused research proposals in our program solicitation for new research and educational proposals. We received one such proposal, "Distributed Observatories for the Coastal Environment." Professor Henrik Schmidt of the Ocean Engineering Department succeeded Jim Bellingham as principal investigator. This project is now in its fourth year with a completion date of February 2005.

Our most recent focused research project began in March of 2001. "Biomimetic Rigid-Hull Vehicle with Flapping Foils for Enhanced Agility in the Surf Zone and Cluttered Environments" was submitted by Professor Michael Triantafyllou of the Ocean Engineering Department at MIT with Professor Dick Yue, also of the Ocean Engineering Department as the co-principal investigator. The long term goal of this research is to develop a new class of rigid-hull autonomous underwater vehicles, best adapted to environments that require continuous maneuvering. This project begun in March of last year and will be completed in February 2007.

National Strategic Initiatives

In the competition for new funded research as part of the 1999 National Strategic Initiative (NSI) we were fortunate to receive favorable reviews for our proposal, MIT Sea Grant Technology Program in Sea Scallop Mariculture, with Professor Chrys Chryssostomidis and Cliff Goudey as co-principal investigators. The objectives of this program are to develop, refine and foster the commercialization of several innovative technologies needed by the Northeast sea scallop industry for its conversion to a sustainable, more economically viable industry. The technologies include improved harvesting systems for scallop seed and market-sized scallops, scallop bed monitoring, predator control and seed transport. This project enjoys significant collaboration with a number of experts and practitioners in the industry. The project began in March of 2000 and having had an eighteen-month duration, is now complete.

Two national strategic initiative projects begun in September of 2000 are effectively at their completion stage. These projects are: "Environmental Marine Biotechnology: Development of Oligonucleotide Gene Chips as Sensors for Diverse Marine Pathogens" with Professor Martin Polz of the Civil and Environmental Engineering Department at MIT and Professor Ee Lin Lim, formerly associated with MIT and Professor Polz, and now with Temple University; and "Environmental Marine Biotechnology: Mussel Plasma Histidine-rich Glycoprotein (HRG)—Biomarker, Key to Metal Transport, Novel Natural Product" submitted by Professor William Robinson, Professor Manickam Sugumaran and Professor Gordon Wallace all of UMASS/ Boston.

This years (2002) NSI solicitation included opportunities for fellowships in two areas. Stephanie Wood, a PhD candidate in environmental biology at the University of Massachusetts/Boston submitted a proposal, "Dynamics of Recolonization in a Depleted Population: A Study of the Gray Seal (Halichoerus grypus) in New England," in the Sea Grant Fisheries Fellowship competition. Joseph Curran, a candidate for the masters degree in ocean engineering at MIT submitted a proposal in the Sea Grant Industrial Fellowship competition, "Imaging from AUVs with LED Illumination." Both of these proposals were successful and are funded.

Education

Sea Grant is committed to providing learning opportunities for students, professionals, and the public. Support for graduate students is included in almost every research project. In addition, the program continues to provide major support for marine related Undergraduate Research Opportunities Program (UROP) projects. Sea Grant UROP directly provided $25,000. A substantial contribution from the Department of Ocean Engineering and the MIT UROP itself raised this to a total of $50,000.

Completed in February of 2000 was a one-year educational project proposed by Cliff Goudey as principal investigator assisted by Brandy Moran as associate investigator—both members of the MIT Sea Grant Advisory staff. "Aquaculture Courses for Massachusetts High School Students" was proposed as an effective means of satisfying the need to incorporate meaningful classroom material into high school curricula that recognized science and technology principles.

Based on the success of this effort MIT Sea Grant (MITSG) produced the curriculum "Marine Aquaculture: Raising Saltwater Fish in the Classroom." Currently there are four schools piloting the material in their classrooms, three classes in Massachusetts and one in Connecticut.

- Essex Agriculture High School has built the curriculum's featured 100-gallon tabletop recirculating system in their fish barn where the students are learning about managing a closed ecosystem and observing fish from the Gulf of Maine.
- Upper Cape Cod Technical Institute has used the instructions on how to set up live feed systems. The juniors and seniors are learning about population

dynamics and fish nutrition by incorporating the management of life feed production into their aquaculture program.

- Nauset Regional High School is collaborating with the Eastham Aquaculture Training Center, using their tanks. Our curriculum is used as a model for inventorying and monitoring winter flounder that were provided by MITSG.
- The Sound School in Connecticut has a unique aquaculture class where the students set up their own systems. They are using our curriculum material to set up a hatchery that focuses on rotifer production.

Each of these schools has been conducting aquaculture in their classroom for several years. With support from MITSG staff and other experts in the field, these schools were able to enhance their educational programs with this advanced curriculum.

There has been great interest from the local teaching community in Massachusetts revealing a strong pull towards aquaculture and a desire to learn how to integrate our marine aquaculture curriculum into their classroom as a project-based learning experience. Most of these teachers do not feel that they are experienced enough to tackle the curriculum without any training or support.

.Due to the extraordinary enthusiasm of those participating in this educational experiment and the resulting commitment from the schools we provided additional funding for Brandy Moran to develop Grants for Education in Marine Science as a seed project. This project solicited proposals from interested teachers to develop similar classroom curricula in marine sciences. We were able to support seven of the proposals submitted. At the end of the grant period in May of this year we hosted a symposium to report the results and plan further activity in this educational area.

Three educational projects completed this past February. The Quincy Public Schools completed their two-year project—"Develop and Implement Local Marine Curriculum for Quincy Public Schools."

Guide to Marine Hitchhikers, submitted by Judy Pederson, Manager of the MITSG Center for Coastal Resources, a one year project extending Dr. Pederson's work in bringing much needed discipline to the problem of nonindigenous marine organisms spreading throughout the world, was a one year project that began in 2001

The second educational program begun last year was submitted by John C. Buckley, a teacher with the Cohasset Middle High School, "Moving Beyond 'Just Another High School Research Project': Designing and Implementing Coastal Community Research that Meet Rigorous Professional Review Standards," was a one year project. Mr. Buckley's proposal evolved out of an environmental education program, the Cohasset High School Summer Institute, partially supported by the Cohasset Education Foundation.

Advisory Services and Technology Transfer

In September of 2001 an 18 month project began under the direction of Cliff Goudey, project director, Center for Fisheries Engineering Research—"A Coastal Community Development Program for Massachusetts." The objectives of this project are to assess any changed needs in Massachusetts for outreach in coastal community development issues. This project involves strategic and collaborative processes to better respond to these needs. A significant factor in this process is the need to address home port security in light of the implications resulting from the September 11 attacks last year.

The MIT Sea Grant Communications/Information Service, under the leadership of Andrea Cohen, produces outreach materials for a wide variety of consumers. This includes the newsletter, Two if by Sea, published jointly by the MIT and WHOI Sea Grant Programs. Two if By Sea highlights the research, advisory and outreach activities of Sea Grant programs in the Commonwealth, and provides the public with information about coastal and marine issues in the region.

Communications produces and distributes all of the program's technical reports and distributes and archives all program publications. We maintain a reference center with journals and books, which is available to the community for informational purposes. We also provide information to schools, businesses, government, citizens, media, the MIT community and others on a wide range of marine-related topics.

The goal of the MITSG Center for Coastal Resources (MITSG CCR), under the leadership of Judy Pederson, is to serve as a link between scientific and technical research, and information, and the user community, such as state and federal agencies, local government, non-government organizations and citizens. This past year, the MITSG Center for Coastal Resources under the direction of Dr. Pederson, focused its outreach activities on three areas: marine bioinvasions, habitats and marine protected areas, and pollution-related issues for Boston Harbor and the Charles River.

The CCR is in the process of organizing a workshop to identify and implement a regional approach to managing ballast water releases in nearshore coastal areas. The region includes Atlantic Canada Provinces through to the Port of New York/New Jersey and will focus on shipping agents, port authority managers and directors, state and

federal agencies and the New England Governors and Premiers. In addition, the CCR will be convening the Third International Conference on Marine Bioinvasions in the spring of 2003. Both conferences will highlight the scientific and technical issues related to managing marine bioinvasions.

In addition to the workshops and conferences, the CCR continues to produce materials for the public to educate and involve them in identifying non-native species. As an experiment, the CCR is asking for the public to send us requested information on selected species by mailing back a business reply mail postcard and verification in the form of a photo or preserved organism. We will be posting the data on a web site, along with information about non-native species in Massachusetts and New England.

One proposed solution to conservation of biodiversity is protection of habitats through the establishment of marine protected areas (similar to National Parks and Wilderness areas). The fishing closures represent one type of marine protected area, but do not meet all the criteria of those who want to preserve special habitats and rare species. Geographic information systems (GIS) provide visualization of data layers and allows one to identify highly sensitive areas and areas that recover readily when disturbed. The CCR is developing an approach for assessing proposed areas for their vulnerability and making access to a GIS program accessible on the web. This can serve both to educate and to log in responses from the user community on what areas they think should be set aside (or not).

The Center for Marine Social Sciences (CMSS) is actively pursuing its goal of applying advances in social sciences to help resolve marine related issues and to contribute to policy development. CMSS continues to work with state and federal agencies and the public to identify and address local and regional needs in fisheries and coastal zone management. Marine advisory agent Madeleine Hall-Arber continues to track the social impact of new fisheries regulations and is currently working on a project to study fishing-dependent communities in New England. Dr. Hall-Arber works in an extensive advisory capacity with the New England Fisheries Management Council's Social Science Advisory Committee. In July of this year The Cape Cod Chronicle published an article featuring Dr. Hall-Arber's research titled "Report Chronicles Social Impact of Fisheries Regulations."

Program Management

The program director is Professor Chryssostomos Chryssostomidis, department head of Ocean Engineering. Associate directors for research are Professor Henrik Schmidt and Dr. E. Eric Adams. Richard Morris continues to serve as executive officer for the program. Timothy Downes continues as the program's administrative officer.

Dean John A. Knauss Marine Policy Fellowship was established in 1979 to provide a unique educational experience to students who have an interest in ocean, coastal and Great Lakes resources and in the national policy decisions affecting those resources. The program, which is sponsored by the National Oceanic and Atmospheric Administration's (NOAA) National Sea Grant College Program, matches highly qualified graduate students with "hosts" in the legislative branch, executive branch, or appropriate associations/ institutions located in the Washington, D.C. area, for a one year paid fellowship. The program is named in honor of one of Sea Grant's founders, former NOAA Administrator, John A. Knauss. This past year we nominated Rachel Adams for the fellowship who subsequently was selected. Rachel is currently a candidate for the PhD degree in environmental chemistry with the Department of Civil and Environmental Engineering at MIT.

MIT Sea Grant administers the Doherty Professorship endowed by the Henry L. and Grace Doherty Foundation. Professor Bernhardt Trout of the Department of Chemical Engineering and Assistant Professor Julian Sachs of the Earth, Atmospheric and Planetary Sciences Department continue in the second year of their Doherty Professorships.

The call for nominees this year resulted in the selection of Professor Alexandra H. Techet, assistant professor of ocean engineering. Professor Techet's proposal, "Embedded MEMS based Shear Stress Sensors for Flow Measurement and Control of Marine Vehicles," represents an important use of Micro Electro Mechanical Systems (MEMS) in active flow control which coupled with active shape change can greatly improve the performance of robotic underwater systems.

The Doherty Professorship for Professor Techet will run for two years.

Chryssostomos Chryssostomidis
Director
Henry L. and Grace Doherty Professor in Ocean Science and Engineering

More information about the Sea Grant College Program can be found on the web at http://web.mit.edu/seagrant/www/.

Technology and Development Program

The primary mission of the Technology and Development Program (TDP) is to provide a focus at MIT for research and education related to the role of technology in the socioeconomic development of newly industrialized nations. TDP works with other academic departments and research centers throughout MIT to:

- Promote an awareness of the relationship between science, technology, and development on the part of faculty and students at MIT
- Provide a focal point for the technology and development activities of faculty, students, and visiting scholars interested in the field of technology and development
- Assist the faculty, students, and staff of collaborating institutions in other countries to develop research and academic interests consistent with their national needs
- Serve as a contact for interested organizations outside MIT (government, academic, private sector) to access the Institute's resources and its knowledge of developing countries—particularly of their socio-economic and technological problems

TDP carries out these objectives through research, academic programs, and contacts with international and national organizations that have an interest in broad areas of technology and development. In order to fully utilize available resources, TDP is structured to interact with other academic departments and research centers throughout MIT.

Current Research Programs in Thailand

TDP in Thailand collaborates in research and education with two major Thai institutions—the Collaborative Program of Science and Technology with the National Science Technology and Development Agency of Thailand, and the Collaborative Program of Science and Technology with the King Mongkut University of Technology at Thonburi. These two programs are funded under an agreement with Suskapatana Foundation, and both started in 1996. Both activities are currently being continued at a slower pace due to the economic hardship in Thailand. Professor Kevin Amaratunga continued his work on the Thailand Integrated Water Resource Management System Project.

Current Research Programs in Malaysia

A Memorandum of Understanding was signed by MIT and the MUST-Ehsan Foundation effective January 1, 2002. The agreement describes the relationship of the parties in the establishment of the Malaysia University of Science and Technology (MUST) as a not-for-profit, tax exempt, private science and technology-based research-oriented institution of higher learning, and an intellectually elite institution catering to the brightest students of Malaysia and the region. MIT's activities in this collaboration with MUST are being supported by Motorola, Inc., acting through its Global Telecom Solutions Sector and its Global Software Group ($7 million over five years) and the Motorola Foundation ($18 million over five years).

MIT is committed to making all reasonable efforts to assist MUST in four broad areas—development of graduate degree programs in selected areas; establishment of a research agenda; formation of partnerships with the private sector; and development of an appropriate institutional organization, including but not limited to administration and finance.

For more information on the program, see the web site at http://www.must.edu.my/.

Future Research Initiatives

The Technology and Development Program has had several preliminary discussions with appropriate institutions in Colombia and Egypt.

In Colombia, TDP and the Mariano Ospina Foundation have jointly prepared a proposal to establish an institute for research and education on large-scale infrastructure systems in Bogota. Discussions are still ongoing with the Office of the Prime Minister on the possibility of establishing a university similar to the Malaysia University of Science and Technology.

Current Education Initiatives

The TDP-sponsored Middle East Program at MIT completed its twelfth year. The program (under the direction of Professor Nazli Choucri, TDP associate director) involves faculty from the Department of Political Science, the Department of Economics, the History Faculty, the Department of Urban Studies and Planning, the Sloan School of Management, the Department of Civil and Environmental Engineering, the Science, Technology and Society Program, and the Aga Khan Program in Islamic Architecture. The program enables students with an interest in the Middle East to develop an expertise in the area in addition to their own academic fields of specialization, and it examines the processes of socioeconomic change, technological development, political change, institutional development, capital flows, and business and investment patterns in the region.

TDP's primary educational activities outside MIT are currently being focused on its collaboration with the Malaysia University of Science and Technology. Beginning in September 2002, the following MIT courses will be offered at MUST: Foundations of Software

Engineering; Introduction to E-Business; Database, Internet, and Systems Integration Technologies; Animal Cell Biotechnology; Basic Biology of Biotechnology; Fermentation Technology; Introduction to Transport and Logistics; Flow Systems; Transportation Demand and Economics; and Introduction to Intelligent Transportation Systems.

In the spring the following courses are to be offered: Distributed Development of Engineering Information Systems; Global Information Systems: Communications and Connectivity Among Information Systems; Information Processing for Engineering Systems; Kinetics of Biological Systems, Downstream Processing; Bioinformatics: Principles, Methods and Applications; Transportation Policy, Strategy, and Management; Project Evaluation; Carrier Systems, Public Transportation Service and Operations Planning; and Advanced Intelligent Transportation Systems. Several other graduate courses are in various stages of development for spring offerings.

Organization

The TDP director is Professor Fred Moavenzadeh, professor of construction management in the Department of Civil and Environmental Engineering. Professor Nazli Choucri of the Department of Political Science is the program's associate director, and Patricia Vargas is the assistant director.

Fred Moavenzadeh
Director
George Macomber Professor of Construction Engineering and Management

More information on the Technology and Development Program can be found online at http://www-tdp.mit.edu/.

Technology Licensing Office

The mission of the Technology Licensing Office (TLO) is to facilitate the transfer to industry of technology from MIT, Lincoln Laboratory and the Whitehead Institute, and thereby to benefit the public good through the development and subsequent sale of commercial products. A secondary goal is to generate unrestricted funds to motivate inventors and to support research and education at MIT. The TLO staff of 29 (14 licensing professionals and 15 administrative and support personnel) are responsible for identifying marketable technologies, managing the patenting and copyrighting of these technologies, finding licensees to develop the technologies and negotiating licenses.

Despite the poor economic conditions, the cash income of the TLO this year without revenue from liquidated equity set a record of $32.9 million. As always, much of this income represents patents filed and licenses signed five to 10 years before; thus our total revenue is somewhat less sensitive to current economic conditions than might be expected. Revenue from liquidated equity, in contrast, was very low—only $663,000, reflecting a poor market for IPO's and mergers. Total income, the sum of the two was $33.5 million.

We consummated 112 new technology licenses and 31 new option agreements (a total of 153 agreements, for an increase of over 20 percent in number of agreements from last year.). Twenty-four of these agreements were to new startup companies—a surprising number considering the known decrease in venture capital activity nationwide (This compares to 26 new company agreements in FY2001. We also granted 41 end use software licenses and signed up 13 new trademark licensees in FY2002, for a total of 76 trademarked vendors licensed.

With over 650 active licenses in house and over 150 startup companies extant (with equity in about 60 of them), we can expect that royalty streams will continue to mature and companies will reach equity liquidity, but the timing is unpredictable. Studies by others have shown that the average university license that matures into products takes eight years to do so. The stream of new inventions continues at over 400 per year (484 in this fiscal year, compared to 446 last year), refilling the pipeline.

TLO staff are also active contributors to student activities at MIT. These include judging in the "50K" student business plan contest, guest lectures on patents and licensing in a number of Engineering, HST and Sloan School courses, both undergraduate and graduate, and "open door coaching" for students thinking of starting a business, whether through an MIT license or not.

Members of the TLO are actively involved in disseminating our technology transfer and entrepreneurship processes and practices to University of Cambridge and other United Kingdom universities as part of the CMI program. Staff exchanges between the MIT TLO and the University of Cambridge tech transfer office are underway as part of this project, and we are planning a series of educational seminars for UK universities in the current year.

Senior TLO staff also served pro bono on the boards or senior committees of a number of national, state, and local entrepreneurial and tech transfer organizations.

They have served usually pro bono as advisors to over a dozen university or governmental technology transfer offices in a number of countries and to the International AIDS Vaccine Initiative, in addition to hosting literally dozens of visits from other such organizations and corresponding company departments.

Lita Nelsen
Director

More information about the Technology Licensing Office can be found on the web at http://web.mit.edu/tlo/www/.

Associate Provost

The associate provost assists the provost in academic administration. The associate provost oversees MIT Lincoln Laboratory, addresses the Institute's relationships with federal agencies, and is responsible for campus space usage and planning.

In assuming oversight of MIT Lincoln Laboratory for the senior administration, the associate provost participates in regular meetings of the Lincoln Director's Office, the steering committee, and the advisory board. He also works with the MIT Lincoln-Campus Interaction Committee to foster increased participation between Lincoln Lab and the academic departments.

The associate provost took on the chairmanship of the Committee for Review of Space Planning (CRSP), which oversees space assignments and renovations. He also sits on the Building Committee and Capital Projects Committee. This past year, a subcommittee of CRSP was formed to expedite project review and to allow the full CRSP to concentrate on larger and longer-range issues. Aside from the ongoing renovations, some of the issues addressed this year include the NW sector, life-science needs, the plans for addressing the Bosworth building of the Main Group and the general issue of deferred maintenance, and the development (by the Department of Facilities) of a comprehensive space management system.

Working closely with the vice president for federal relations, the associate provost has worked to establish communications with key federal agencies.

Together with the vice president for research, the associate provost co-chaired a special Committee on the Protection of Human Life and Infrastructure, which was formed by the president and provost following the events of September 11. This committee considered possible Institute responses to those events and delivered a draft report, which is under review.

Claude R. Canizares
Associate Provost
Bruno Rossi Professor of Experimental Physics

Director, Lincoln Laboratory

Lincoln Laboratory is a mission-oriented laboratory operated by MIT for the Department of Defense (DoD) carrying out research and development in surveillance, identification, and communications. The laboratory continued a celebration during the academic year of its establishment fifty years ago, in 1951, as Project Lincoln by MIT in response to a request from the Army, Navy, and Air Force. During the past year, agencies of the DoD—namely, the Air Force, the Army, the Navy, the Defense Advanced Research Projects Agency, the Ballistic Missile Defense Office, and the National Reconnaissance Office—supplied approximately 86 percent of the laboratory's budgetary support. The Federal Aviation Administration provided most of the non-DoD support, which additionally includes work for the National Aeronautics and Space Administration and the National Oceanographic and Atmospheric Agency. Lincoln Laboratory also carries out pre-competitive research with industry under approved Cooperative Research and Development Agreements. For the federal fiscal year 2001, Lincoln Laboratory received $380.3 million, supporting the efforts of 1,200 professional technical staff.

The following administrative changes occurred at the Laboratory Steering Committee level. Associate Provost Claude L. Caniares was appointed to the Laboratory Steering Committee and serves as the campus liaison. Professor David H. Staelin, who had served on the Steering Committee and part-time as assistant director, has returned full time to the Department of Electrical Engineering and Computer Science. Dr. Kenneth D. Senne was appointed technology investment officer. Mr. Lee O. Upton, assistant director, was also named head of the Sensor Technology Division, formerly the Air Defense Division.

Activity at the laboratory focuses on DoD tasks in surveillance, missile defense and air defense, information extraction, and communications and information technology, supported by advanced electronic technology and on air traffic control technology for the Federal Aviation Administration. Technical work areas include radar and optical sensors, measurements, and systems; communications; signal design and processing; identification algorithms; lasers; solid-state devices; digital technology, circuitry, and data systems; and tactical control systems. Unclassified summaries of several accomplishments during the past year are presented below.

Surveillance Technology

Urban Biological Defense

The Defense Threat Reduction Agency (DTRA) selected Lincoln Laboratory to lead a nine-month study on a proposed means of dealing with a bioterrorist attack on US cities. This follows a study done for DTRA in 2001 on "Health Surveillance and Biodefense," described in last year's report. The new study expands a health-surveillance-only system into a much broader-based detection and reporting system that includes environmental sensors and considers implications of connecting into an already existing consequence management network. The current study includes participation from MIT, Harvard, and consultants, including medical, public health, and urban specialists. The goal is to develop a realistic architecture for an urban system based on technology that could be available today or in the near future.

LINEAR

The Lincoln Near Earth Asteroid Research (LINEAR) project continues to operate a wide-area asteroid search program employing an advanced electro-optics search system originally developed for Air Force-sponsored space surveillance applications. A third telescope using the same advanced technology has been recently added to the program. This newest telescope is dedicated to following up and improving the orbit accuracy of the asteroids found with the two search systems. The LINEAR system has generated over 9 million observations during the period of March 1998 to July 2002. These observations account for over half of all observations in the Minor Planet Center archives, and 70 percent of all new asteroid discoveries since 1998. LINEAR has discovered 995 near-Earth asteroids (1,940 total known), 87 comets, and over 165,000 main belt asteroids.

Lincoln Laboratory joined with the nonprofit Science Service to begin the Ceres Connection activity that honors students in fifth through twelfth grades and their teachers in the naming of minor planets. The students and teachers are selected through the Science Service competitions, the Discovery Youth Science Challenge, Intel Science Talent Search, Intel International Science and Engineering Fair, and Intel Excellence in Teaching Award. The Ceres Connection has honored 264 students and teachers with minor planets so far this year.

Imaging Radar Technology Study

Lincoln Laboratory conducted a six-month study to investigate the feasibility of developing a millimeter-wave satellite imaging radar at Haystack and to develop a preliminary system design. The objective is to demonstrate imaging of small satellites at ranges out to geosynchronous orbits. The combination of short wavelength, wide bandwidth, and sensitivity (signal-to-noise ratio) needed for this task has never been demonstrated and will require a very significant advancement in radar technology. The proposed radar, named Deep View, will be built upon the infrastructure of the Haystack radar at the Lincoln Space Surveillance Complex in Westford, Massachusetts. The

radar will operate in the W frequency band (96 GHz). The 37-m-diameter Haystack antenna would require resurfacing to <100-μm tolerance to efficiently transmit and receive at W-band. To simultaneously achieve the high power and wide bandwidth, the Deep View radar will combine an innovative sparse-band multiplexed gyrotron transmitter architecture and signal processing. The sparse-band design removes the bandwidth limitations of individual high-power amplifiers and has potential applications in other military high-resolution radar systems.

First Demonstration of an Integrated Solid-State 3-D Laser Radar Detector Array

Lincoln Laboratory successfully demonstrated the first operation of an integrated solid-state detector array for three-dimensional (3-D) laser radar during DARPA-sponsored field trials at Eglin Air Force Base, Florida, in December 2001. The detector consisted of a 32-by-32 array of single-photon-sensitive avalanche photodiodes bonded to a commensurate array of CMOS timing circuitry. The 3-D laser radar operated with a 532-nm frequency-doubled Nd:YAG laser transmitter with at a 5-kHz pulse repetition rate. This system measured three-dimensional shapes of objects by performing a laser ranging measurement for every pixel.

Geosynchronous Satellite Encounters

In January 1997 Telstar 401, a geosynchronous communications satellite, failed on-orbit with no ability to be boosted from the populous geosynchronous belt. Without station-keeping capability, Telstar 401 will oscillate indefinitely from 97 to 113 degrees west longitude in a geopotential well centered at 105 west, posing a long-term threat to numerous active satellites. Another geosynchronous satellite, Solidaridad 1, failed on-orbit in August 2000 and also became a threatening drifter. Lincoln Laboratory has monitored nearly one hundred encounters of these two drifters with active satellites in the past five years. This work is performed under a Cooperative Research and Development Agreement (CRDA) with four commercial satellite operators. There are numerous other drifting, inactive satellites besides Telstar 401 and Solidaridad 1 that pose a threat to the active geosynchronous population. Lincoln Laboratory has developed an automated system to predict and monitor all such encounters of the drifting population with the CRDA-partner active satellites.

Meteor Radar Data Analysis

Lincoln Laboratory was selected to lead a multi-year effort, sponsored by NASA, to assess the meteoroid threat to orbiting spacecraft. High-power radar data indicate that there is a high probability of damage to an orbiting satellite, due to the unexpectedly large number of microgram-class meteoroids moving with high velocities. Meteor data were collected by the ALTAIR radar located on the Kwajalein Atoll during the Perseid 1998 shower and the Leonid 1998 and 1999 showers with an average detection rate of one meteor every two seconds. ALTAIR collected data at approximately 100-km altitude, where meteoroids entering the Earth's atmosphere form plasmas. These data were analyzed to determine meteoroid radius, density and mass. Accurate mass and density distributions can now be employed in environment models, which will have a significant impact upon spacecraft meteoroid risk analyses.

Monitoring Space Weather with GPS

Lincoln Laboratory has computed Global Positioning System (GPS) maps of total electron content at various locations using data from approximately 150 GPS receivers across the North American continent for several large geomagnetic storms. These maps have been used to monitor the time evolution of ionospheric-storm-enhanced density, a known "space weather phenomenon." During the storms studied, plasma is transported to higher latitudes and to earlier local times—approaching the noon meridian. The storm-enhanced-density total-electron-content plumes, seen in the GPS data, map directly into the dramatic plasmaspheric tails observed in the images collected by NASA's IMAGE satellite. This is one of the first proven observations of a magnetospheric phenomenon measured by a ground-based system.

Earth Observing 1 Mission: Advanced Land Imager

Advanced Land Imager (ALI) has been operating successfully on orbit for twenty months, well over the originally planned mission duration of one year. Currently, sixteen images per day, on average, are being collected for a variety of government and commercial interests. The success of ALI has lead NASA to select ALI as the benchmark design for the Landsat Data Continuity Mission, currently in the formulation phase by two contractor teams selected competitively. Lincoln Laboratory is supporting NASA in these procurement activities and helping the contractors understand the ALI technology.

Missile Defense and Air Defense

Missile Defense Changes

The nation's approach to ballistic missile defense (BMD) is going through significant change. The Anti Ballistic Missile Treaty with Russia has ended, and options such as mobile sensors and interceptors for missile defense can now be utilized. There is no longer a requirement to carefully delineate between national and theater missile defense, and a single system of integrated elements can be developed. A capability-based development concept is being utilized, with the initial capability available in late 2004 and future improvements planned in subsequent two-year increments. A collaborative government-FFRDC-industry

national team has been formed to focus on the critical system-architecture trades. The laboratory is a major participant in laying out the future architecture for the BMD system. A BMD system test bed that can be deployed with contingency capability in the event of an emergency is being considered.

Sea Based Midcourse Defense Program

Lincoln Laboratory has been helping develop a theater ballistic missile defense capability as part of the Sea Based Midcourse Defense Program. The challenges associated with detection, discrimination, and handover of hostile targets within a missile complex are an area of active laboratory work. The laboratory has developed a midcourse discrimination architecture including algorithms for synthetic wideband radar measurements and algorithms to improve two-color infrared focal-plane performance. Two intercept flight tests have been attempted to date, both of which successfully hit the incoming missile.

Advanced Air and Missile Defense Technologies

Multiple applications demand large-aperture radars and advanced missile systems to counter emerging threats and new missions. Large-aperture radars stress technology by requiring large dynamic range, multiple electronic beams formed on receive using high-performance digital signal processors, and on-board jamming resistance. We are working for the Navy on demonstrating a digital array radar to sample the RF signals close to the antenna phase. Once the signals are digitized, we will implement a system based on an open system architecture to permit easy transfer of the innovative algorithms to new systems as computing technology evolves. This effort is synergistic with advances in signal processing technologies for missile seekers. In both cases, large antenna arrays and missile seekers, the architecture and algorithms are implemented in a processor-independent signal processing software architecture. We have successfully demonstrated portability from a network of workstations to embedded systems, thus achieving the predicted improved performance for a new class of missile discrimination algorithms.

High Energy Laser Beam Control Technology

As a result of renewed DoD interest in tactical high-energy lasers, Lincoln Laboratory has expanded its efforts in high-energy laser beam control technology. Research programs are focusing on several technologies critical to the success of tactical high energy laser systems. To study beam-control concepts, Lincoln Laboratory operates the Advanced Concepts Laboratory under Air Force sponsorship. This laboratory is designed to explore unconventional and innovative techniques for adaptive-optics compensation and tracking.

Under sponsorship from the Joint Technology Office, Lincoln Laboratory is integrating another beam-control laboratory to investigate the effects of thermal blooming, a phenomenon resulting from laser heating of the atmosphere. In a related measurements program, Lincoln Laboratory is leading an effort to identify candidate atmospheric transmission windows in order to reduce the effects of thermal blooming.

A 3-D laser radar system is being developed for installation on the SeaLite beam director at White Sands Missile Range, New Mexico. The 3-D laser radar and associated track algorithms will enable target tracking in cluttered environments where conventional image-tracking techniques fail.

Airborne Seeker Test Bed

The Airborne Seeker Test Bed, in a Gulfstream II aircraft, has participated this year in two major test campaigns and infrastructure upgrades. One of the test campaigns was conducted in Nevada to evaluate the effectiveness of electronic countermeasures against a modern surface-to-air missile system and to measure bistatic radar cross sections. The second test utilized the seeker test bed's IR focal-plane arrays and IR seekers to test flare countermeasures.

Information Extraction

Knowledge-Aided Sensor Signal Processing and Expert Reasoning

The challenge of accurately geo-locating, identifying, and engaging enemy mobile air defense systems is considered a high priority for our force structure, due to the demonstrated ability of these threats to shoot and move on a very short timeline. To address this problem, we have begun a new effort for DARPA to improve the performance of ground moving-target indicators and synthetic aperture radars in detecting and tracking ground mobile threats by exploiting *a priori* knowledge. The techniques rely on delimited terrain maps, information from other cooperative sensors, and aggregated knowledge from previous measurements. These techniques are highly computational intensive. However, with the advances in computing technology, the practicality of these techniques is within reach. The laboratory is working jointly with industry to develop a high-performance digital signal processor system that can be embedded in experimental aircraft.

Undersea Warfare Systems

Lincoln Laboratory has provided algorithm capability for sonar classification to the Los Angeles–class submarine fleet. Operator feedback from the testing of the Lincoln Interactive Passive Acoustic Classifier has established confidence in the promise of automated aids to classification. This technology has been successfully transitioned to the submarine fleet for different classes of towed arrays. The application of this technology is expanding to new sensors and additional threats.

GPS Pseudolite System

Lincoln Laboratory is working with industry to demonstrate a phase array instrumented in an airborne platform to serve as a relay of GPS coordinates. The approach would permit suppression of jamming interference while maintaining enough signal-to-interference ratios for airborne users. A demonstration of a seven-element array in an anechoic chamber has been completed with a series of flight tests planned for next year.

Multi-Sensor Fusion and Exploitation

Over the past two years, an integrated visualization and target recognition system that supports the intelligence community was developed and deployed. This system provides a capability to visualize color-fused three-dimensional scenes of areas of interest. Automatic search algorithms for detecting terrain features within these scenes can be trained using a simple graphical user interface. This same system was also integrated into an automatic target recognition system that was deployed to a ground station. This automatic target recognition system screens incoming data for significant targets such as surface-to-air missile systems. This work is now focused on integrating the fusion and target recognition system and designing a user interface. Also work has started to address the integration of passive data sources for improved detection and false alarm performance.

Communications and Information Technology

Optical Communications Technology

Optical logic gates are potential building blocks for all optical routers and would permit the routing of optical packets without the need for optical signal to electrical signal conversion, then back to optical signal. The laboratory has demonstrated switching of optical packets based on decoding the packet address optically at a line rate of 112.5 Gbps. In related work, the laboratory demonstrated the world's fastest all-optical-exclusive OR (XOR) function. The XOR operates at 50 Gbps. The laboratory and campus researchers are now examining ways to reduce the physical size of all-optical logic gates to make these circuits practical in future optical networks.

Army Communications

The Lincoln Laboratory Satellite Communications On The Move effort completed the test-bed-equipped vehicle and demonstrated the initial concept. The test bed incorporated an antenna positioner that can compensate for the vehicle-motion and blockage-mitigation protocols that compensate for the loss of signal.

Tools for FAA Cyber-Security Analysts

Lincoln Laboratory has been working with the Federal Aviation Administration (FAA) to improve the efficiency and effectiveness of FAA cyber-security analysts. These analysts have the responsibility for detecting computer attacks against FAA networks. Working with the FAA and the government inter-agency Technical Support Working Group, prototype tools were developed and demonstrated by using real FAA network data. These tools are currently in the alpha and beta testing phases.

Air Traffic Control

Automation Tools

Lincoln Laboratory is working with the FAA and NASA to enhance air safety, reduce controller workload, and increase airport capacity by developing planning aids for air traffic controllers. A NASA-sponsored effort is underway to integrate advanced weather products developed by Lincoln Laboratory into the Center Terminal Automation System developed by NASA. This activity helps coordinate activities between arrival controllers located at en route centers and final-approach controllers located at radar control facilities. The focus of initial work is on integrating wind field products from the Integrated Terminal Weather System in order to improve aircraft trajectory estimates. Additional work is being carried out to determine the delay-reduction potential of automated traffic spacing advisories for air traffic controllers.

Air Traffic Surveillance Technology Improvements

The laboratory has undertaken an FAA program to perform flight-test validation of Automatic Dependent Surveillance Broadcast in the US and Europe. The technology, developed at the laboratory, uses the Mode S secondary radar frequency and data formats to broadcast aircraft-derived position and state information. It enables air-to-air and air-to-ground exchange of more precise and timely information in support of improving the efficiency of air traffic management. The FAA is also sponsoring the laboratory 's effort to assist development of time-difference multilateration, a technique for surveillance of the airport surface that will form the basis for improved management of surface traffic and the prevention of runway incursions.

Aviation Weather Surveillance and Forecasting

The laboratory has made significant progress in automated thunderstorm forecasting and is demonstrating this operationally at key terminal and en route air traffic control facilities. The time horizon for the forecasts has been extended to two hours and their accuracy improved through identification of storm type and through detection of storm initiation, growth, and decay. The laboratory's automated forecast of ceiling and visibility changes at San Francisco is in its second year of operational demonstration, and will be transferred to the National Weather Service for long-term operations.

The laboratory-developed and industry-produced Integrated Terminal Weather System is now operational at Kansas City, Houston, and Atlanta, and will be deployed to thirty additional large airports during 2003. The laboratory continues to operate prototypes covering six airports and is assisting the FAA in deployment and enhancement of the production Integrated Terminal Weather System. A Corridor Integrated Weather System extends high-resolution Integrated Terminal Weather System weather products and thunderstorm forecasts to the congested airspace over the eastern seaboard and upper Midwest. This system is used by FAA traffic management specialists at five en route centers, six large terminal radar control facilities, and the FAA command center outside Washington.

Electronic Devices

Liquid Immersion Lithography

The semiconductor industry's roadmap anticipates that by the year 2010 the smallest features in an integrated circuit will be 45 nm. Within the next four to six years, as the dimensions shrink to 65 nm, optical projection will be performed with 157-nm radiation, a technology that was first developed at Lincoln Laboratory. However, even 157-nm lithography will encounter difficulties in patterning the 45-nm structures needed by the end of the decade. To meet this need, Lincoln Laboratory is exploring the incorporation of transparent liquids between the optical system and the resist-coated silicon wafer. This approach, which in effect increases the numerical aperture of the optical system, is well known in the visible and near-ultraviolet wavelengths as "oil immersion microscopy." For its application to the specific requirements of lithography at very short wavelengths, Lincoln Laboratory has identified a class of suitable transparent liquids, and has demonstrated their effectiveness by printing 30-nm lines and spaces in a 157-nm liquid-immersion interference configuration. These are the smallest dense features printed to date with optical methods.

Fiber-Laser Beam Combining

Lincoln Laboratory has recently demonstrated that the beams from five fiber lasers can be "wavelength-combined" so that the output appears as a nearly diffraction-limited ideal laser beam. This is made possible by operation of each laser at a slightly different wavelength, which then enables the lasers' output beams to be combined by spatially overlapping the beams so that they all propagate coaxially. This new approach is applicable to other types of laser arrays, such as diode laser arrays, and experiments show scalability of the wavelength-beam-combining technique to arrays containing hundreds of lasers.

Aluminum-Free, Mid-Infrared Semiconductor Lasers

Lincoln Laboratory has recently developed a GaSb-based, ~4-μm-wavelength semiconductor laser design that is free of aluminum. This was accomplished by replacing the typically used AlAsSb optical cladding layers with GaSb in quantum-well laser design. A careful analysis of previously published data indicated that GaSb would have a refractive index less than that of the GaInAsSb waveguiding layer by ~0.06. This small refractive index step resulted in the laser-beam far-field divergence being reduced by a factor of three from ~80° to ~25°. The collected power efficiencies were measured to be up to two times greater than the best previous devices. To date, the highest output power measured from a single facet is 5 W_{peak}. The aluminum-free structure also simplifies material growth and device fabrication, thus enabling new device structures.

Slab-Coupled Semiconductor Lasers with Single-Spatial, Large-Diameter Mode

High-power single-mode semiconductor diode lasers, with outputs that can easily be coupled into single-mode fibers, are of interest for a variety of applications. Conventional single-mode diode lasers are typically restricted to modest output powers and feature elliptical beams that require expensive packaging schemes with external lenses to achieve efficient optical coupling to single-mode fibers. A new approach to this problem has now been demonstrated in the slab-coupled optical waveguide laser (SCOWL). The SCOWL combines modern quantum-well gain regions with low-loss passive slab-coupled rib waveguide concepts. This design permits single-mode lasers with larger, nearly circular modes permitting easy coupling into fibers. The large mode size also results in reduced power density at the facets. Other features enable efficient, high-power operation. To date, 980-nm SCOWLs with continuous-wave output powers greater than 1.2 W, electrical-to-optical efficiency greater than 35 percent, average brightness of greater than 100 MW/cm^2-str, and butt-coupled (no lenses) efficiency of greater than 84 percent into a single-mode fiber have been demonstrated.

Superconducting Circuits for Quantum Computation

In collaboration with MIT's Department of Electrical Engineering and Computer Science, and the Harvard University Physics Department, Lincoln Laboratory is developing superconductive quantum devices for application to quantum computation. This collaboration has designed, fabricated, and measured the amount of stored flux in a micrometer-scale superconductive circuit as a function of the applied magnetic field and has observed two states in the circuit, as well as evidence for resonant transitions induced by quantum-mechanical tunneling between these states. This result is a first step towards developing a useful superconductive gate for quantum computation.

Scientific Charge-Couple Imagers

Lincoln Laboratory has developed wide-spectral-bandwidth, large-format charge-coupled imagers for astronomy applications. Over the past year, processes have been developed that give near reflection-limited detector quantum efficiency from the ultraviolet to the near infrared. To improve the ultraviolet response, where the silicon absorption length is a few nanometers, a high-boron-doped, thin single-crystal silicon layer was grown on the device surface to create an electric field that efficiently accelerates the photoelectrons into the charge detection well. A process was developed that uses molecular beam epitaxy to grow a few-monolayers-thick layer on 150-mm wafers. Multilayer antireflection coatings were used to maximize broadband response and reduce Fabry-Perot interference effects. Atop Mauna Kea on the island of Hawaii, the Canada-France-Hawaii observatory recently discovered 30 new moons orbiting Jupiter, Saturn, and Neptune by using a 2-by-6 array of Lincoln Laboratory 2048-by-4096-pixel CCD imagers (>100 million pixels). These observations doubled the number of such moons known to orbit the planet and is the largest number of satellites ever discovered at one time.

David L. Briggs
Director

More information about Lincoln Laboratory can be found on the web at http://www.ll.mit.edu/.

Associate Provost for the Arts

The arts at MIT have been an important presence during this past, difficult year. At the same time, there have been some major developments in resources, programs, and new initiatives. The Office of the Associate Provost for the Arts has also seen a number of changes.

Resources and Programs

Perhaps the most moving demonstration of the importance of the arts to the MIT community came with the playing of the recording of the Adagietto from Mahler's Fifth Symphony by the MIT Symphony Orchestra for the community meeting in Killian Court on September 12. Another initiative in response to the attack on the World Trade Center was the swift design and construction of the Memorial Wall near the Chapel on Kresge Oval.

Academic year 2002 also saw initiatives for collaboration with MIT/Italy and MIT/France. In conjunction with MIT/Italy, the associate provost for the arts sponsored a successful residency by Sergio Escobar, managing director of the Piccolo Teatro, who gave a public address on "Science and Theatre."

The associate provost for the arts and the Office of the Arts also co-sponsored a symposium on the play "Copenhagen" with the Goethe Institut. Moderated by Alan Brody, the panelists included Laszlo Tisza, MIT professor of physics, emeritus; Gerald Holton, Harvard professor of physics, emeritus; Jochen Heisenberg, professor of physics, University of New Hampshire; and actors Mariette Hartley, Len Cariou and Hank Stratton of the Boston production. The audience filled Wong Auditorium to overflowing and an equally large number watched the stream in the lounge. Lynn Heinemann of the Office of the Arts was responsible for the coordination of the event and did a superb job.

Fall 2001 also saw a pilot project for the Freshman Arts Seminar and Advising Program. It consisted of three sections headed by Alan Brody; Martin Marks, senior lecturer in music; and Jane Farver and Bill Arning of the List Visual Arts Center (LVAC). The program received support from the d'Arbeloff fund to expand to five sections in fall 2002.

The MIT Museum opened its most significant exhibit to date, "Mind and Hand," focusing on the experience of the MIT student through history. Deborah Douglas, curator of the exhibit, is currently adding a section on the arts.

It was agreed that the plans for the Laboratory for the Performing Arts should be decoupled from the renovations of the Wiesner Building. Planning began for a new site, the selection of an architect, the creation of a steering committee, and aggressive fundraising for the $15 million project.

Exploratory meetings began in conjunction with the Program in Comparative Media Studies for collaboration with the Royal Shakespeare Company.

The Creative Arts Council met with the dean of undergraduate student life to develop a program for a visiting artist's residence in Simmons Hall.

The Office of the Arts sponsored the screening of Eric d'Arbeloff's film *Phranc* at the Boston Jewish Film Festival.

Associate provost for the arts Alan Brody gave the opening address, "Beckett and Nothingness: Levine and Somethingness," at the opening of professor of visual arts Ed Levine's exhibition of photographs "Waiting for Godot" at the Boston Public Library.

The Knight Foundation voted to renew funding for the Museum Loan Network for another three years.

National Engagement and K–12

This was the second year of operations for Teachers as Scholars with double the number of seminars offered over the previous pilot year.

The associate provost for the arts contributed a chapter to "Passion and Industry: Schools That Focus on the Arts," a publication of the National Arts and Learning Foundation.

The List Visual Arts Center (LVAC) continued a team-taught course with the arts director of the Cambridge Rindge and Latin School, introducing high school students to opportunities for careers in the arts. The LVAC also hired a full-time educational outreach coordinator.

The MIT Museum expanded its offerings to K–12 groups and hired Signe Pereira as director of educational programs.

The associate provost for the arts continued to serve as the MIT representative on the board of trustees of the Museum of Fine Arts and a member of the Education Committee of the board . He also joined the board of advisers for Teachers as Scholars.

Changes and Transitions

For family reasons, Jane Pickering sadly announced her decision to take a position at the Yale Peabody Museum after four extraordinary years as director of the MIT Museum. A search committee has been formed to find her replacement.

Maureen Costello decided to apply for long-term disability and to leave her position as director of special programs after more than ten years of exemplary service. A search for her replacement has begun.

The arts also lost four major and much beloved figures during AY2002. David Epstein, professor of music and

longtime conductor of the MIT Symphony, and Ed Cohen, senior lecturer in music and head of the composition program, died within months of each other.

Gyorgy Kepes, founder of the Center for Advanced Visual Studies, died in the fall. A well-attended memorial and celebration of his work occurred in Kresge Auditorium on June 9.

Finally, the MIT community also lost Walter Rosenblith, former provost and one of the early driving forces of the establishment of the Council for the Arts at MIT.

Alan Brody
Associate Provost for the Arts
Professor of Theater Arts

More information about the Office of the Associate Provost for the Arts can be found on the web at http://web.mit.edu/arts/associate_provost/.

List Visual Arts Center

The List Visual Arts Center's mission is to present the most challenging, forward-thinking, and lasting expressions of modern and contemporary art to the MIT community and general public in order to broaden the scope and depth of cultural experiences available on campus. LVAC's mission also is to reflect and support the diversity of the MIT community through the presentation of diverse cultural expressions. This is accomplished through four avenues: changing exhibitions of contemporary art in all media, by the most advanced visual artists working today, that take place in the LVAC galleries (E15); the permanent collection of art (comprising large outdoor sculptures, artworks sited in offices and departments throughout campus, as well as art commissioned under MIT's Percent-for-Art policy, which allocates funds from new building construction or renovation for art); the Student Loan Art Program, a collection of fine art prints, photos and other multiples, maintained solely for loan to MIT students during the course of the academic year; and extensive interpretive programs to offer the MIT community and the public various perspectives about LVAC changing exhibitions and MIT's art collections.

Current Goals

—Continue to present the finest international contemporary art that has relevance to the MIT community.

—Institute a new guest curator program.

—Preserve, conserve, and resite works from the permanent collection.

—Make needed alterations to the gallery spaces.

—Continue to increase audience both from MIT campus and from Boston area.

—Use new educator to increase cross-disciplinary and collaborative use of LVAC's exhibitions, programs and facilities.

Accomplishments

—Increased attendance to 15,520, the highest numbers since 1994, when actual attendance counts replaced estimated figures.

—Offered weekly gallery tours led by an LVAC staff member on Wednesday and Sunday afternoons. The tours were open to MIT faculty, staff, and students, as well as the general public.

—Provided tours of exhibitions and the permanent art collection on campus to 96 groups.

—Implemented a new exhibit space, the Media Test Wall. This 8' x 8' rear-projection screen located in the hallway of MIT's Building 56 features a compilation of videos by contemporary artists that play in a continuous loop 24 hours a day.

—Made loans of approximately 200 artworks to various departments and individuals across the MIT campus.

—Offered the Wasserman Forum on Contemporary Art.

—Received more than 40 positive critical reviews for exhibitions, including reviews in the *Boston Globe*, *Boston Herald*, *Boston Phoenix*, *Boston Metro*, *Boston Magazine*, *Harvard Crimson*, *Art on Paper*, *Art in America*, *Art New England*, *New Art Examiner*, *Arts Media*, *Artnews*, *Artforum*, *Parachute*, *Museums Boston*, *Tema Celeste*, *Time Out NY*, *Concierge*, *Technology Review*, *Bay Windows*, *Cambridge Tab*, *Surface Magazine*, *Takara Magazine*, *J Magazine*, *This Side Up!*, *WHERE Magazine*, *the Daily Yomiuri: International*, *South End News*, *Playbill*, *Patriot Ledger*, *Tech Talk*, *Arts Editor*, *AIU*, WBUR, *Rock & Roll Library*, and numerous web publications.

—Completed a commission by artist Jorge Pardo to create a new work for the NW30 residence.

—Made purchases or received donations of 43 new works to add to the Student Loan Art Program, the majority of which were exhibited in the Stratton Student Center during the academic year. They will be cycled into the lending collection in the fall of 2002.

—Completed a comprehensive self-survey in preparation for the American Association of Museum's site visit and 10-year reaccreditation.

—Completed an inventory of all public art in the central zone of the MIT campus.

—Created and updated a color map of the MIT campus highlighting 27 major public art works

—Began a residency by artist Paul Pfeiffer in collaboration with the Artist-in-Residence Program of the Office for the Arts that permitted the artist to explore rapid prototyping and other technologies and that will culminate in an exhibition in early 2003.

—Debuted "Race in Digital Space" as part of the USC-MIT Conference on Race in Digital Space; the exhibition was subsequently presented at the Studio Museum in Harlem in New York City.

—Conserved Jacques Lipchitz's "Bather" and reinstalled it in the Hayden Courtyard.

—Completed final reinstallation of Jean Ipousteguy's "Cenotaphe," which had been conserved in 2000.

—Conducted an accessibility survey of the galleries with Very Special Arts (VSA) Massachusetts.

—Hosted a gallery exhibition tour for MIT Council for the Arts members during their annual meeting.

—Participated in the Freshman Arts Program Orientation and Campus Preview weekend programs, providing tours and receptions.

—Facilitated the List Essay Prize for writing on contemporary visual art, which was won by undergraduate Tina Lin.

—Implemented the second year of ArtWorks, a program in conjunction with Cambridge Rindge-Latin School. This after-school program provided tours and seminars for students interested in careers in the arts. Students met with the director, curators, registrar, and exhibition designer at the List Center, toured the MIT Media and Glass Labs, and visited facilities and met with staff of other Boston-area institutions, including the Museum of Fine Arts, Harvard Conservation Labs, architects Sasaki Associates, and web-design firm Partners and Simons. This program was so successful that Rindge-Latin has asked that it be repeated annually.

—Amended the Collections Management Policy to include a code of ethics and statements regarding the Native American Graves Protection and Repatriation Act and the acquisition of objects of Nazi-era provenance.

Exhibitions

"Student Loan Art Exhibition" (LVAC galleries, September 4–16, 2001). Annual exhibition of 350 works comprising the Student Loan Art Collection. MIT students may view displayed works and then enter a lottery to be awarded the work of their choice on loan for the academic year to hang in their dormitory, apartment or office.

"YES YOKO ONO" (LVAC galleries, October 18 through January 6, 2002). Organized by the Japan Society, this was Yoko Ono's first American retrospective. The popular exhibition offered a comprehensive reevaluation of Ono's prolific 40-year career, exploring her position within the postwar international avant-garde and her critical and influential role in originating forms of avant-garde art, music, film, and performance.

"Competitive Edges" (Media Test Wall, Building 56, January through April, 2002). This rear projection screen, located on the ground floor of MIT's Whitaker building, brings art out of the gallery where it can be encountered 24 hours a day by the MIT community and visitors. This first program was a thematic compilation of videos by Risk Hazekamp, Jesal Kapadia, Ingeborg Lüscher, and Euan Macdonald that looked at competition from a variety of viewpoints.

"AA Bronson: Mirror Mirror" (LVAC galleries, February 7 through March 31, 2002). This was Bronson's first solo exhibition in New England since General Idea, his 25-year collaboration in art and life with Felix Partz and Jorge Zontal, ended when they died of AIDS in 1994. The exhibition included photographs, installation works, wall paintings, and video. The exhibition was accompanied by an artist-designed catalogue, including an introduction by LVAC curator Bill Arning, who organized the exhibition.

"tele-journeys" (LVAC galleries, May 2 through July 7, 2002). MIT professor and internationally recognized artist Joan Jonas and List Visual Arts Center director Jane Farver organized "tele-journeys." The exhibition, which included single channel videos, sound, films, and video installations, focused on young artists from around the world who are living and working in Western Europe while expanding the vocabulary of performance- and installation-based conceptual art. It featured artists Carlos Amorales, Mark Bain, Yael Bartana, Michael Blum, Nabila Irshaid, Runa Islam, Sebastian Diaz Morales, Tomoko Take, and Fiona Tan. The exhibition was accompanied by a catalogue with an essay by independent curator and critic Jens Hoffmann and introductory remarks by Joan Jonas and Jane Farver.

"Spinning" (Media Test Wall, Building 56, May through present). The second installment of the Media Test Wall, this series, selected by Yasu Nakamori, examined 10 works that use spinning movements and circular/spherical figures in contemporary video. The international artists presented were Marco Brambilla, Ursula Scherrer and Michael J. Schumacher, Hiroshi Ono, Hussein Chalayan and Marcus Tomlinson, Jeroen Kooijmans, Magnus Wallin, Bruce Yonemoto, Koki Tanaka, Spencer Baker, and Rico Gatson.

Interpretive Program Highlights

LVAC curatorial and education staff led 96 gallery tours for such groups as the Visual Arts Program at MIT, the Council for the Arts at MIT, Artists Behind the Desk, MIT's Asian Studies Program, the School of the Museum of Fine Arts, Mass. College of Art, Rhode Island School of Design (RISD), the Art Institute of Boston, University of Massachusetts-Boston, Harvard University, Emerson University, Suffolk University, Dreyfuss University, Boston University, Gordon College, New England School of Art and Design, Tufts University, Pratt Institute, Elderhostel of Museum of Science, Spring House (Brookline MA), Carnegie Museum, St. Scholastic Academy (Colorado), University of Massachusetts-Amherst, Polter Road School, Boston Aquarium staffers, and the Stockholm School of Economics.

The Annual Max Wasserman Forum on Contemporary Art was attended by 422 people. The panel discussion was titled "Losing the Revolution: A discussion on the loss of seditious potential when avant-garde art and rock music stopped sleeping in the same bed." Andrea Miller-Keller served as moderator for a panel made up of Laura Cottingham, Dan Graham, Dick Hebdige, and Paul Miller a.k.a. DJ Spooky (That Subliminal Kid). The donor considered this to be the most successful forum to date.

Arts Boston Critical Dialogues (ABCD) presented a panel discussion, "The Anomalous Museum: Arts Spaces in Institutions of Higher Learning," moderated by Bill Arning. Panelists included Laura Donaldson, acting director, Gallery and Visiting Artists Program, Monsterrat

College of Art, Beverly, MA; Joe Ketner, director, Rose Art Museum, Brandeis University; Linda Norden associate curator of contemporary art, Fogg Art Museum, Harvard University; Judith Tannenbaum Richard Brown Baker Curator of Contemporary Art, Museum of Art, RISD.

Lecture by Andrea Zittel, co-sponsored with the School of the Museum of Fine Arts, Boston.

"YES YOKO ONO": A lecture by Yoko Ono about her work was held in the Bartos Theater, with a live telecast available in Room 26-100. Min Tanaka, Japanese Butoh dancer, presented a solo dance recital to Ono's music in the atrium of Building E15.

"AA Bronson: Mirror Mirror": The artist AA Bronson hosted a walk-through of the exhibition offering the public personal insight into his works. Curator Bill Arning presented a walk-through of the exhibition on three separate occasions. A lecture given by Robert Atkins, New York–based art historian, columnist for *The Village Voice*, and author of *ArtSpeak: A Guide to Contemporary Ideas, Movements*, and *Buzzwords*, among other books, was entitled "The Artworld, Community and Activism: A Meditation Inspired by the Events of September 11th." An evening of videos by General Idea was held in the Bartos Theater.

"tele-journeys": A panel discussion featuring the exhibiting artists was held in conjunction with the MIT Comparative Media Studies Program. LVAC director and co-curator Jane Farver presented a walk-through of the exhibition. The exhibiting artists visited three classes and four student-artist studios in the MIT Visual Arts Program.

Collections

Permanent Collection

There were 12 gifts of art to the collection, including works by Ann Hamilton, Dennis Oppenheim, John Coplans, Amanda Means, Joseph Beuys, and Roxy Paine. Donors included Vera G. List, Herbert and Susan Bard, John Coplans, and an anonymous donor.

Percent for Art

With many major new MIT construction and renovation projects underway, curator Kathy Goncharov oversaw the continued development of several artworks. Jorge Pardo's ceiling piece in NW30 opened in the fall, while construction is well underway for works by Matthew Ritchie in the Zesiger Sports and Fitness Center and Dan Graham in the Simmons Hall dormitory. Photographs by Candida Hofer were purchased for the Department of Aeronatics and Astronautics, while teams have been organized to develop art programs for the Sidney Pacific dorm and the Vassar streetscape.

Student Loan Art Program Collection

The Student Loan Art Program attracted 1,183 MIT students to the LVAC gallery over the period of the exhibition of artworks. A total of 533 students submitted entries to the lottery to borrow artwork and approximately 285 works were disbursed. A special website dedicated to this program was begun by staff and will be completed during the summer of 2002.

Administrative Changes

—Formed Collections and Development Committees composed of Advisory Council and staff members.

—Instituted weekly long-range planning meetings for staff.

—Restructured staff to include one curatorial position dedicated to collection and percent-for-art projects and a position dedicated to education and outreach. These positions were filled by Kathy Goncharov and Hiroko Kikuchi.

—Provided training for 14 interns from Harvard, RISD, Tufts, Mass. College of Art, School of Museum of Fine Arts, Brown, Yale, Brandeis, and Boston University, as well as individuals who have previously completed school.

In addition, the LVAC director and curator took on the responsibility of providing academic counseling as freshman advisors to seven students. In this connection, several arts activities were held during the fall.

Finances/Funding

The Artworks Program received $10,000 from the Boston Foundation, $2,000 from the Sally and Milton Avery Foundation, and $1,700 from the Cambridge Arts Council.

"tele-journeys" received donations from the LEF Foundation of $8,000, while the British Council and French Cultural Services each gave $700. The Mondriaan Foundation supplied the exhibit with $16,500, the Dutch Consulate in New York donated $2,500, and the Netherland-America Foundation donated $2,000.

"AA Bronson: Mirror Mirror" received a donation in the amount of $42,187.50 from IMLS, MIT Council for the Arts supplied $23,600, Massachusetts Cultural Council donated $15,000, Fay Chandler gave $10,000, the Canadian General donated $2,200, and the Friends of Boston Art donated $1,304.61.

Michael Joo received funding from the LEF Foundation in the sum of $7,000.

Robert Sanders designated a $200,000 gift for MIT's Percent for Art Program.

Martin Zimmerman is awarding funds to permit the use of outside curators to supplement the List Center staff.

The Media Test Wall received an award from The John H. '29 and H. Naomi Tomfohrde Foundation of $9,500.

Save Outdoor Sculpture gave $700 to assess the condition of works commissioned in the 1980s for Building E15.

Donations in kind were received by: Royal Sonesta Hotel, Sapporo USA, Hotel at MIT, Cambridge SoundWorks, Sound Seal, Circa 50.com, Trader Joe's, Minuteman Press, Canadian Consulate General, Phoenix Media Communications Group, Four Seasons Greenery.

Future Goals

—Use LVAC web site to provide information about Student Art Loan Program (currently being developed) and permanent collection. Also to provide additional opportunities for artists to do web-based projects, beginning with Matthew Ritchie, who is creating a new work for the Zesiger Sports and Fitness Center under the MIT Percent-for-Art Program. This requires outside expertise and staff training.

—Develop comprehensive educational materials about all of the MIT Percent-for-Art projects. We would like to create documentary videotapes about the percent for art and artist residency projects. This requires additional funding and expertise.

—Develop comprehensive program of exhibitions and public programs consistent with MIT's mission that can attract large-scale funding.

—Expand upon the Media Test Wall's effort to present art in other sites on campus, beginning in the coming year with a small exhibition of works by contemporary Japanese artist Yukinori Yanagi for the MIT Japan Program offices.

—Develop web-based systems for providing self-guided tours and for implementing exhibition organization and better in-house communication.

Personnel Information

In March-April, director Jane Farver completed research begun with a grant from the Asian Cultural Council to travel to study new media art in Japan. She participated in grant-making panels for Etant-donnes for the Government of France in Paris and Los Angeles. She was a panelist for the Bogliasco Foundation (Genoa), conducted studio critiques, and met with graduate students and the School of the Museum of Fine Arts Boston. She has been invited to contribute essays to ART/Asia Pacific Magazine and an exhibition catalogue at the Americas Society in New York.

Curator Bill Arning presented lectures at Mass. College of Art, School of the Museum of Fine Art, the Institute of Contemporary Art in Boston, RISD, Cornell University, Virginia Commonwealth University, Brandeis University, and Montserrat College. He was a panelist or juror for the Boston Center for the Arts, the Silvermine Guild, and the New American Painting Journal. He contributed essays to catalogues produced by University of California at Riverside, Bard College, Art Pace, and the Museum of Salamanca. He also serves on the board of White Columns, ONI Gallery, and The Gallery at Green St.

Kathleen Goncharov has been brought on as curator of public art. She comes from the New School University in New York City, where she expanded the university collection from 200 to over 1,100 works in a variety of media. She has held numerous contemporary art positions around the globe, including curating sections of La Biennale Di Venezia and the seventh Triennale in New Delhi. She is the recipient of numerous grants, including a Peter Norton Foundation Research Grant, Curator-in-Residence at the Banff Centre for the Arts in Canada, and the NEA Museum Fellowship.

Advisory Board

Jenny Frutchy was appointed the new chair of the LVAC Advisory Board Committee.

The following committees were established: Long Range Planning, Collections, and Development.

Jane Farver
Director

More information about the MIT List Visual Arts Center can be found at http://mit.edu/lvac/.

MIT Museum

The mission of the MIT Museum is to document, interpret, and communicate to a diverse audience the activities and achievements of the Massachusetts Institute of Technology and the worldwide impact of its innovation, particularly in the fields of science and technology; and to enhance the spirit of community inside the Institute through the promotion of dialog both at MIT and between the Institute and the wider world.

Highlights

The MIT Museum celebrated several milestones and achievements in AY2002.

We marked our 30th anniversary, as well as reaccreditation by the American Association of Museums for a ten-year period. Of the 8,000 museums nationwide, only about 750 are accredited, so the MIT Museum is proud to be part of this select group.

A reunion of Project Whirlwind alumni/ae was held at the museum in September 2001. More than 70 people attended the full day of events that included a special display of artifacts. The staff interviewed participants and accepted donations of photographs and other artifacts for the Science and Technology Collections. A reception acknowledging the donation of the Digital Equipment Corporation Historic Computer Collection to the museum by the Compaq Computer Corporation preceded a dinner sponsored by Mitre. Speakers included Jay Forrester, Robert Everrett and Kenneth Olson.

In October, as part of the Council for the Arts annual meeting, we unveiled a plaque acknowledging the major donors to our renovation project, and thanked all of the donors who helped to fund our new façade, dramatic stairway entrance, and visitor services area. This project has just received an Honor Award for Design Excellence from the Boston Society of Architects, International Interior Design Association, and the American Society of Interior Designers.

The museum served 37,713 visitors this year, including 2,992 children and parents who participated in our popular Family Adventures in Science and Technology and Friday After Thanksgiving Science Chain Reaction.

Collections

We completed the first phase of the renovation and refurbishment of our collections storage areas, which included the installation of roller-racking storage units in one area. Once the latter were installed, our painting and half-hull model collections were rehoused in this superior system. With a grant from the National Endowment for the Humanities, we hired a consultant to conduct a conservation assessment of the most significant films in our media collection. As part of this project, over 200 films were processed, cleaned, and inventoried in the database that has been created for the MIT General Film Collection.

We drafted policies governing collecting, including guidelines for the types of personal effects that will be acquired for the MIT General Collection, and collecting strategies for the Holography Collection. The Collections Committee and director approved seven new acquisitions, including a 19th century alidade used by MIT students from 1880 to 1945; the track ball invented by a Lincoln Laboratory researcher working on the BMEWS (Ballistic Missile Early Warning System) project and considered an antecedent to today's computer mouse; and a model of the control room for the Whirlwind computer. The registrar and collections manager processed 17 loans, including nine incoming loans for museum exhibitions, and eight loans out to the National Academy of Sciences, Edgerton Explorit Center, Peggy Notebaert Nature Center, Hotel at MIT, and MIT campus locations.

Architecture and Design Collections

The search for a curator of architecture and design was completed in the spring, and Gary Van Zante, presently curator of the southeastern architectural archive at Tulane University, has been hired and will join the staff in September. In the interim, Nicole Lapenta, a trained archivist, has been working with us on a temporary basis and has provided invaluable assistance to researchers. She has also worked on an Institute of Museum and Library Services (IMLS) Conservation Project Support grant to organize and process the Marjorie Pierce '22 Collection of architectural drawings, and to organize and inventory the Professor Richard Filipowski Collection of paintings, drawings, sketches, architectural drawings and sculptures.

Hart Nautical Collections

A variety of new exhibits, programs and collections management activities were initiated. "Perils of the Sea," an exhibition of prints from our Arthur H. Clark Collection, opened at the museum in March and will run through November. It was organized with the assistance of a retired curator from the Boston Museum of Fine Arts who contributed hundreds of volunteer hours of research time. A series of seven evening lectures featuring an STS graduate student and an MIT Sea Grant AUV (autonomous underwater vehicle) lab manager, among other speakers, is being offered in conjunction with the exhibition. The first phase of planned upgrades to the Ocean Engineering exhibition in the Hart Nautical Gallery was completed with the construction of a highly accurate mock-up of a full- AUV. Professor Chrys Chryssostomidis and his Sea Grant AUV Lab staff made this possible by making obsolete parts available and by advising museum staff on the correct procedures for assembly. The third year of our IAP "boat building" program, held in January, was the most

successful ever. The course was retooled into two shorter classes on building half-hull models and lofting plans for construction. Plans from Hart for the original Tech Dingy by Professor George Owen were used for both classes. Sixteen students utilized the Department of Architecture's woodshop to make their models and loft the Tech Dinghy. John Lednicky '44 OE helped to fund these exhibitions and classes through a generous gift.

We made progress on improving collections access. The entire collection of over 250 half-hull models was recataloged and digitally imaged in the process of moving them from temporary storage to a new state-of-the-art compact storage room funded by the Institute. In June a volunteer intern from the International Yacht Restoration School began a project to catalog and digitally image a small but rare and previously uncataloged plan collection.

The collections continue to be heavily used with about 1,000 inquiries received via phone, fax, email, and mail.

Holography Collections

The museum is completing a project to provide autonomous, online access to the Holography Collection for its international audience. Working with support from Information Systems and an independent consultant, the database, which includes images, is currently a password-protected site so that data can be verified and the structure evaluated by the likely principal users in the international holographic community. After this stage it will be opened up to a wider audience. It will be inviting, image-centric, non-intimidating, browsable and searchable, and include links to other web sites, particularly those related to holography education, including "Eye on Holography," which is being developed by our Learning Technologies Coordinator. The latter will expose museum visitors to holographic tools and applications, thus helping them to better understand the processes, products, and implications of holography.

This year we also began the cataloging and housing of the recently acquired collection of holograms by the late artist Anait Stephens. And we worked with Color Scope Productions and the Spatial Imaging Group of the Media Lab on a documentary film on holography and the work of Professor Steve Benton that features holograms from our collection.

Photograph and Film Collections

Staff received and responded to over 300 requests for information about the photograph and film collections, including 100 requests for photographs. In addition, there were 80 research visitors. These collections have been used extensively by MIT departments and offices, in particular, as a visual resource for expanding departmental web sites. The collections also proved to be a significant resource to mark the 50th anniversary of the Sloan School and Center for International Studies.

The collections supported local initiatives such as the Boston History Collaborative's development of an "Innovation Odyssey" tour. They also are a resource for the academic and popular press such as the Washington Post and Smart Computing. Popular topics of interest have included Thomas Kuhn and John Nash. They were used in a wide variety of publications from textbooks on basic electronics to academic studies of the Air Force during the Cold War.

Science and Technology Collections

Work on Phase II of the "Mind and Hand" exhibition began. The final section of the exhibition will be redesigned to incorporate a unit on the humanities, arts and social sciences. More than a dozen distinguished faculty and staff members participated in two seminars to help conceptualize the design. Research and planning for a short-term exhibition based on the collection of 18,000 negatives illustrating the work of the MIT Radiation Laboratory was begun. It will open in November and run through May 2003. Planning for an exhibition on the history of aviation in New England (with a special emphasis on MIT) was initiated in May. This will be a collaborative project involving MIT faculty, students and alumni/ae as well as numerous aviation organizations, including the Aero Club of New England, the American Institute of Aeronautics and Astronautics and the Federal Aviation Administration. It will open in December 2003 and be on view through June 2004, and will be accompanied by a full series of education and public programs.

The curator responded to over 150 inquiries about artifacts and related archival materials. She assisted documentary programs for public television, including a significant project on Norbert Weiner and the influence of cybernetics on artists (German/French public television); the WGBH/Annenberg Foundation Series "Learning Math"; and photographers and authors from Mass High Tech, Toronto Globe Mail, NASA, and the Naval Undersea Warfare Museum. She also worked with a curator and exhibit planner from the Museum of Flight (Seattle, WA) through a grant from the Museum Loan Network.

Her work with the MIT community included a lecture to a class in Science, Technology, and Society (STS.001), supervision of an STS graduate student's independent study project, and participation in the MIT Center for the Study of Diversity in Science, Technology, and Medicine's "Research Workshop on 'Race' and/in the History of Technology." She also conducted special tours for Knight and Dibner Fellows.

Education and Outreach

This was a year of growth and development for the Education and Public Programs staff. With permanent funding from the Institute, we were able to hire Signe Pereira as our new full-time education coordinator. A

National Science Foundation (NSF) grant awarded to the Media Lab for the Playful Invention and Exploration network, a three-year collaboration involving several museums throughout the United States, including the MIT Museum, is supporting Stephanie Hunt, our new learning technologies coordinator. These two positions have significantly increased our ability to develop, implement and expand programming.

Family Programs

The museum's monthly family program series, Family Adventures in Science and Technology (F.A.S.T.), and the Friday After Thanksgiving (F.A.T.) Science Chain Reaction with Arthur Ganson, continued to attract substantial media attention and record numbers of enthusiastic visitors. This year, hands-on F.A.S.T. programs were co-developed and generously staffed by students, faculty, and researchers from Materials Science (Glass Laboratory), Mathematics, Plasma Science and Fusion Center, Media Laboratory, Whitehead Institute and Leaders for Manufacturing Program. Together, F.A.S.T. and F.A.T. provided high quality, MIT-centered science and technology experiences for 3,000 visitors. F.A.S.T. has grown in popularity to the point where we have increased the number we are hosting, and F.A.T. has grown in size so that we now hold the event in duPont Gymnasium.

Through our partnership with the Media Lab in the Playful Invention and Exploration network, we were able to launch a twice-monthly series of programs called Invention Studios, utilizing emerging technologies. They introduce the public to the exploration of these technologies in new and highly innovative ways.

During the holiday weekend of January 19-21, we sponsored Cambridge Kids Free weekend. Invitations were distributed to all public elementary schoolchildren in Cambridge, and 706 students and parents visited us. We also offered drop-in programs during the February and April school vacation weeks. The February program, "Zoom into Engineering," was co-sponsored with the School of Engineering and WGBH Boston, and coincided with National Engineers Week. The April program, "Gear Heads," explored the world of mechanical sculpture and offered the opportunity for schoolchildren to create their own works using gears, cams, pulleys, motors and cranks. Both series were well attended with over 2,000 participants.

School and Group Programs

The museum's popular school and group programs served students throughout the state and greater New England. They have fostered an increase in the diversity of our audience by successfully extending our reach into communities traditionally underserved by museums. We have implemented regular programming targeting homeschoolers who have become a larger segment of our audience. Most of these programs revolve around three-day workshops in holography.

With the Public Service Center and the Office of Government and Community Relations, we launched a new approach to working more closely with the Cambridge Public Schools that will involve us in assisting in systemic change. In September we held our first Educator Open House and are planning to make this a regular event. Teachers from communities such as Rockport, Chelmsford and Framingham have visited with the express purpose of developing interdisciplinary teacher workshops through the museum. This year the Museum Institute for Teaching Science chose us to serve as a regional education partner, and this summer we will be serving 40 teachers from the Boston metropolitan area in their professional development institute focusing on modeling.

We continue to serve the needs of MIT faculty and students through cooperative programming for IAP, the MITE2S/SEED program, and support for student initiatives such as Collision 3 in 3D, a project of the Arts and Technology at Tech group.

Exhibitions

Main Facility

We have implemented a new plan for changing exhibitions in one of the main galleries. The first exhibition in this series is "Perils of the Sea," consisting of 19th century prints from the Hart Nautical Collection. We are currently in the planning stages for a new exhibition on holography that will include a traveling component.

Compton Gallery

The museum installed three new exhibitions in Compton Gallery. Collaborating with the Glass Laboratory, we developed and mounted "Incandescent Spirit," stunning experimental glassworks by the late Page Hazelgrove, which received a great deal of press interest and was ranked by the *Boston Globe* as one of the best exhibitions in Boston. We also hosted "MIT Lincoln Laboratory: Technology in Support of National Security," a 50-year retrospective of the lab's service to the nation in developing a program of research and development pertinent to national defense, with a particular emphasis on advanced electronics. The latest exhibition is entitled "eye," and consists of retina prints and poetry by Center for Advanced Visual Studies (CAVS) senior fellow Elizabeth Goldring. Goldring is a severely visually challenged artist whose work has special significance to other individuals who are visually challenged. This exhibition was designed with these audiences in mind, and includes an audio component of recorded poetry (read by Goldring) and large format text and labels.

Traveling Exhibitions

Two traveling exhibitions organized by the museum are touring museums throughout the United States: "Seeing the Unseen: Photographs by Harold Edgerton" and "Approaching Chaos."

Development

We raised $154,484 in gifts and pledges to support "Mind and Hand: The Making of MIT Scientists and Engineers," and the new arts and humanities section of this exhibition; new exhibitions in Compton Gallery; the Holography and Hart Nautical Collections; a conservation assessment of the film collection; the development of a master plan for the museum's public spaces; and for operating support. The Council for the Arts, Massachusetts Cultural Council, National Endowment for the Humanities, 21 individuals and a foundation comprised the group of generous donors. We will launch a Friends program this summer to broaden our base of support and to provide much needed operating and special project funds.

Visitor Services and Functions

A new visitor services area was created as part of the museum's renovation project, and was designed to incorporate a small retail line of merchandise that relates to exhibitions and programs. We have also partnered with the MIT COOP to develop the MIT Museum Collection that is available for purchase online or by telephone or mail order. Our functions business expanded greatly this year with the addition of a part-time staff member charged with developing this business. We are planning to increase promotion of our functions space to potential customers both within MIT and among the larger event planning community.

Personnel

Three new staff members were hired in the fall: Signe Pereira, education coordinator; Ryan Jimenez, part-time public relations and marketing coordinator; and Claudia Majetich, part-time visitor services and functions manager. Sue Speisman joined our staff in the spring as administrative assistant, succeeding Ellen Weene who left in December. Jane Pickering, who made extraordinary contributions to MIT and the museum as director for four years, resigned in May to move to Connecticut with her family. Mary Leen, the associate director, is serving as acting director while the search is underway for a new director.

Mary Leen
Acting Director

More information about the MIT Museum can be found on the web at http://web.mit.edu/museum/.

Museum Loan Network Program

The Museum Loan Network (MLN) facilitates the long-term loan of art and objects of cultural heritage among US institutions as a way to enhance the installations of museums, thus enabling them to better serve their communities. The MLN grant programs help museums respond to the increasing public demand for installations that are relevant to a range of age groups and cultural heritages and to provide better artistic, cultural and historical contexts for works on display. The MLN programs have led to the sharing of objects among different types of museums, fostering collaborations between institutions of varying size and discipline throughout the US. Funded and initiated by the John S. and James L. Knight Foundation and The Pew Charitable Trusts, the MLN is administered by MIT's Office of the Arts.

Program Development

The program continues to emphasize collaboration and the building of networked resources. The MLN's initiative to include a range of objects of cultural heritage previously outside its domain, continues to evolve. In 2000, the MLN piloted a collaborative program with the American Composers Forum (ACF). Entitled "Museums, Composer, and Communities" (MCC), this pilot program provides museums with an opportunity to work with composers and create new music for their communities. MCC grants were awarded to four institutions, bringing new music and the creative energy of composers directly into museums and their communities. With MCC, the MLN hopes to create new models for interdisciplinary collaboration and enhance the quality of the MLN projects involved in these partnerships. In January 2002, the MLN published and distributed "Museum as Catalyst for Interdisciplinary Collaboration: Beginning a Conversation" (MAC), proceedings of a series of convenings hosted by the MLN in 2000–2001. These meetings, which gathered innovative leaders from different disciplines, explored a number of interrelated issues, challenges and opportunities affecting collaboration and today's museum. It is the hope of the MLN that the conversations reflected in MAC will further the discourse on the role of collaboration and inspire museums to continue to explore new ways of working in their own communities.

Web Site

The MLN online directory, a practical means of identifying objects of cultural heritage available for long-term loan to eligible museums throughout the US, now contains 8,000 objects from 53 institutions. The MLN continues to keep track of the number of hits on the directory and on specific object entries, as well as the number of times each museum with a password has accessed the directory. So far, over 300 museums have obtained passwords to access and search the directory and since January 2000, approximately 7,000 hits have occurred on over 2,750 individual records. The MLN continues to develop virtual exhibitions on its homepage. Featuring projects made possible by MLN implementation grants and designed in conjunction with MIT's Educational Media Creation Center (EMCC), these virtual tours not only provide visual models for museums to understand how to creatively utilize MLN, but also stimulate public interest in the arts and provide greater access to museums' hidden permanent collections. In 2002, MLN's publication "Museum as Catalyst for Interdisciplinary Collaboration: Beginning a Conversation" was made available on MLN's website in pdf format.

Press and Promotion

The MLN continues to work with communications consultant Resnicow/Schroeder, who was hired in the fall of 1998 to lead an aggressive press initiative. The MLN has been very pleased with the long term results of the initiative, which has yielded national and international press, including a feature article in the April 2002 issue of the Italian magazine *Impresa Cultura*.

In its continued effort to increase public awareness about the MLN and its sponsored projects, Resnicow/Schroeder has also been working closely with MLN grantees in trying to develop stories about their projects. The Pew Charitable Trusts highlighted the MLN with a ten-page color article in the summer 2001 issue of their magazine *Trust*. In November 2001, the American Composers Forum newsletter featured its second piece on the MLN-ACF partnership, "Museum, Composers and Communities," an article written by composer William Banfield, who is collaborating with the Mobile Museum of Art. The Billings *Gazette* in Montana also focused on the MLN-ACF pilot program through an article on the Western Heritage Center's project with composer Jim Cockey. The MIT Faculty Newsletter featured an article on the MLN in its October/November 2001 issue, which was circulated to 3,000 members of the MIT community. In addition, MLN projects were highlighted in numerous museum newsletters across the country.

Museum Loan Network News 2000–2001 was printed at a run of 6,000 copies in October 2001 and distributed to museums, foundations and other organizations. This issue prominently focused on the MLN directory, featuring 36 objects from the database in the center foldout section. The MLN has continued to promote the directory and encourage museums to check periodically for new additions.

In March 2002, an e-mail message was sent to the MLN mailing list encouraging them to use the directory and "make a new discovery." The response was very positive and there was a notable increase in usage and in password requests in the weeks following the e-mail.

The MLN director and/or program associates attended and/or lectured about the program and related museum issues at the following annual meetings: the American Association of Museums Meeting, Dallas, TX; the Grantmakers in the Arts annual conference, Lake Mohonk, NY; the New England Museums Association annual meeting, Newport, RI; the "Museums and the Web" conference, Boston, MA; as well as the IMLS "21st Century Learner" conference, Washington, DC. In the fall of 2001, the MLN director gave a presentation at MIT's Academic Council. She also presented an Arts Colloquium on the MLN, which was attended by MIT faculty and staff as well as members of the Council for the Arts. These presentations focused on the mutually beneficial relationship between the MLN and MIT and helped elevate awareness of the program within the MIT community.

Grants

The MLN awards three types of grants to eligible nonprofit institutions in the US: travel grants, survey grants, and implementation grants. At the January 2002 and June 2002 Advisory Committee meetings held at MIT, 40 grants totaling $797,845 were recommended for approval by MIT for funding to museums throughout the country. These awards will facilitate the sharing of a diverse array of objects among museums of differing sizes and disciplines. Grants were awarded to museums with budgets of $25,000 in counties with a population of 2,600 and to institutions with budgets of $52 million in counties with a population of 5.4 million.

Survey grants will allow for a variety of objects to be added to the MLN directory, including Chinese American historical objects from the Chinese Historical Society of America, San Francisco, CA; African American paintings from the DuSable Museum of African-American History, Chicago, IL; French dolls from the Strong Museum, Rochester, NY; Latin American art from the Los Angeles County Museum of Art, CA; Pacific musical instruments from The Field Museum, Chicago, IL; Asian ceramics from the Smithsonian Freer and Sackler Galleries, Washington, DC; and business and advertising ephemera from The New York Historical Society, New York, NY.

Travel grants were awarded to the Cheyenne and Arapaho Tribes of Oklahoma, Concho, OK; the National Underground Railroad Freedom Center, Cincinnati, OH; the Museum of Flight, Seattle, WA; and the Smith College Museum of Art, Northampton, MA, among others.

Implementation grants were awarded to a broad range of institutions including the Cedar Rapids Museum of Art, Cedar Rapids, IA, for the loan of 152 Roman objects; the Pueblo of Jemez Museum of History and Culture, Pueblo, NM, for the loan of 120 Pueblo objects; the Railroad Museum of Pennsylvania, Strasburg, PA, for the loan of a railroad passenger coach; and The Skyscraper Museum, New York, NY, for the loan of the last remaining model of the World Trade Center. In addition, "Museum, Composer, and Communities" grants were awarded to the Cedar Rapids Museum of Art, Cedar Rapids, IA, and the Mobile Museum of Art, Mobile, AL.

Future Plans

The MLN will continue to explore new collaborative relationships (modeled on the ACF pilot partnership) to ensure its relevance to museums and their communities. The John S. and James L. Knight Foundation has approved renewed funding for the MLN over a period of three years starting in October 2002. The amount of the new grant is $2.75 million, including $250,000 for fundraising. The MLN has also submitted a proposal to The Pew Charitable Trusts seeking funding for 2002–2003. In the coming year, the MLN will be seeking new funding sources to ensure its long-term viability.

Lori Gross
Director

More information about the Museum Loan Network can be found on the web at http://loanet.mit.edu/.

Council for the Arts

The academic year 2001–2002 began with the country, and much of the world, in shock after the terrorist attacks of September 11. The Council for the Arts at MIT was deeply affected, as many of our members lost colleagues and neighbors and had to cope daily with the view of a radically altered skyline as a constant reminder of the tragedy. Fortunately, none of our members or any of their immediate family members was lost.

This great tragedy, despite its resulting economic downturn, only served to strengthen the council's commitment to its mission: to foster the arts at MIT. The council had a successful year, as fundraising continued to be strong, and programs flourished.

One of the highlights of the year was an excursion to Seattle and Vancouver from May 23 to 27, attended by approximately 40 council members, spouses and friends.

Council Standing Committees

Annual Meeting (Patricia Chute, chair). The 29th Annual Meeting of the Council for the Arts at MIT took place on October 25 and 26, 2001, and was focused on the visual arts. Council members and guests were treated to a tour of the List Visual Arts Center's Yoko Ono retrospective exhibition, led by curator Bill Arning. Other highlights included the installation of "Reflection Loop," an interactive sculpture featuring the eyes and beaks of 200 "furby dolls" by MIT graduate Kelly Heaton. Heaton received funds from the Grants Committee to create the piece. Council members also had a chance to visit the Glass Lab in Building 4, where they were greeted by Artist-in-Residence Peter Houk. Peter narrated a glassblowing demonstration given by MIT students. Director Ed McCluney then gave a tour of the Student Art Association in the Stratton Student Center.

The Annual Meeting dinner was held on Thursday evening, October 25, at the deCordova Museum in Lincoln, Massachusetts. Isaac Julien, the British installation filmmaker, was presented with the 2001 Eugene McDermott Award in the Arts. Jane Farver, director of the List Visual Arts Center, introduced Mr. Julien, who showed some clips of his recent work.

The Friday morning business meeting began with an address by President Charles M. Vest, who spoke of the crucial role the arts played in the MIT response to the September 11 tragedies. He described the MIT Symphony's contribution, as well as the partial scale model of the World Trade Center built by MIT architecture students as a memorial. He noted that the students immediately used the arts as a means of expression and a way to come to terms with the overwhelming series of events on that awful day.

A number of paintings and sculpture by council member Fay Chandler were on display during this portion of the meeting, and were enjoyed by all present.

Patricia Fuller of the List Visual Arts Center gave a presentation on public art at MIT, and showed us the sites of future works of art, pieces that are being commissioned as part of the MIT Percent for the Arts Program. Every new or renovated building on campus has a percent of its final cost put aside for a new work of art. With the current spate of construction going on, there will be many new pieces added to the collection, such as a Dan Graham for the new Simmons Hall dorm, a Jorge Pardo in the new graduate dorm, and possibly a Richard Serra for the Stata Center.

The Gyorgy Kepes Fellowship Prize was presented to Edward McCluney, director of the MIT Student Art Association (see Special Programs below) at the Annual Meeting luncheon on Friday, October 26 at the MIT Museum. The museum also held a brief thank-you ceremony for the donors who made the renovations to the museum's façade possible.

Arts Scholars Committee (Brit d'Arbeloff, chair). The newest of the council's programs is finally hitting its stride, and the students who make up the group are gradually making it their own. A highlight of the program this year was a field trip, on January 26, to the Massachusetts Museum of Contemporary Art (Mass MoCA) in North Adams, in the western part of the state.

Communications (Pepi Weis, chair). The Communications Committee produced three issues of the council newsletter, *Council Currents*, to great success. *Council Currents* is written by council members, for council members.

Development (Daniel Vershbow '45, chair). As of this writing (6/24/02) the council has raised a total of $330,476 from council members, and a total of $12,105 from non-member donors.

Grants Program (Bradford M. Endicott '49, chair). The Grants Program of the Council for the Arts at MIT awarded 51 grants this academic year, totaling $89,828. Highlights included funding to help refurbish the furnaces in the MIT Glass Lab, support for an ambitious series of concerts of American music spearheaded by Lecturer Frederick Harris, a group exhibition of work by graduate students in the Visual Arts Program, and operating support for the student dance group Movements in Time.

Membership (Bernard G. Palitz '47, chair). As of this writing (6/24/02) council membership stands at 110, with six *ex officio* members and 104 regular members. The following new members have joined the ranks of the council since last July: Anne Bridge Baddour, Margaret

Anne Cullum, Jennifer Frutchy, Melvin Meisinger, Theresa Stone '76, and Peter Wender '71. Sadly, two longtime council members passed away since the last Report to the President: Gyorgy Kepes and Walter A. Rosenblith.

Special Events Committee (Catherine N. Stratton, chair). On May 23, approximately 40 council members and guests gathered in Seattle, Washington, for the "Seattle-Vancouver Arts Adventure." The kick-off event was a cocktail reception at the studio of renowned glass artist Dale Chihuly, situated in a former boathouse. The group was treated to a glass blowing demonstration and the delightful display of the work of the Chihuly studio, as well as Mr. Chihuly's personal collections of a variety of artifacts and memorabilia displayed at the Studio building.

After this splendid start, the assembled enjoyed a tour of the Bellevue Art Museum, a visit to the private collection of Jane and David Davis, and a tour of the Microsoft corporate art collection. The group then traveled to Vancouver, where they met with Arthur Erickson, Canada's preeminent architect, and Martine Reid, widow of First Nations Haida artist Bill Reid. Mr. Erickson and Dr. Reid led a tour of the Museum of Anthropology at the University of British Columbia. Interleafed with brief rests and sumptuous meals, this five-day excursion was enjoyed by all.

Affiliated Committees

List Visual Arts Center Advisory Board (Jennifer Frutchy, chair). The LVAC board continues to be a valuable group of advisors to Director Jane Farver. Longtime chairperson Kitty Glantz stepped down this year, and Jenny Frutchy was chosen as her successor.

MIT Museum Advisory Board (Harvey I. Steinberg '54, chair). Jane Pickering, who in her brief tenure as director re-focused the museum's mission and revitalized its programs, resigned in the spring of 2002. She has taken a position at the Peabody Museum at Yale. A search committee for her successor is being formed as of this writing.

Artist-in-Residence Committee (Stephen Memishian '70, chair). Organized along the lines of the MIT Museum and LVAC boards described above, this committee works with MIT Office of the Arts Director of Special Programs Maureen Costello and a panel of arts professionals, council members and artists to bring artists to the MIT campus to work throughout the Institute.

Special Programs

Since 1980, the council has underwritten MIT's enrollment in the University Membership Program offered by the Boston Museum of Fine Arts. This program provides free admission and discount benefits to all MIT undergraduate and graduate students, as well as ten membership cards for the daily use of MIT faculty and staff.

The free-ticket program with the Boston Symphony Orchestra continued this year. MIT students can obtain, with their student ID, free admittance to Thursday evening and Friday afternoon concerts on a day-of-show, stand-by basis. This year the BSO introduced a new method of ticket distribution, the BSO College Card. The council distributed over 1,500 cards to MIT undergraduate and graduate students. The number of cards and the swiftness with which they were snatched up (800 on the first day of distribution) speaks to the success of this unique program.

Similar programs have been established with other Boston-area orchestras, such as Collage New Music, the Boston Modern Orchestra Program, and the New York Collegium (which has a series of concerts at Jordan Hall).

The successful Student Performing Arts Excursions Series continued, with tickets to the following events made available at no charge to MIT students: a performance of "Othello" at the American Repertory Theater, "Shel's Shorts" (plays based on Shel Silverstein stories) at the new Market Theater in Cambridge, a performance by the Boston Philharmonic, a tribute concert to John Coltrane at Northeastern University, and a performance by the Wayne Shorter Group at the Berklee Performance Center.

The Gyorgy Kepes Fellowship Prize was presented by Angus MacDonald to Edward McCluney at the Annual Meeting luncheon on Friday, Oct. 26. At the Annual Meeting dinner at the deCordova Museum, the Eugene McDermott Award was presented by Dorothea Endicott (McDermott Award Committee chair) to Isaac Julien, an installation filmmaker based in London. Mr. Julien returned to campus in April to present a new film, and meet with several groups of students, as the residency portion of the McDermott Award.

At the Institute Awards Convocation on May 13, associate provost for the arts Alan Brody presented the Laya and Jerome B. Wiesner Student Art Awards to Nathan Fitzgerald '02 and Christopher Rakowski '02, both for achievement in music. The Louis Sudler Prize was presented to Kevin Choi '02 for his accomplishments in filmmaking.

The council established a new program, the Pilchuck Scholarship, at the request of the Glass Lab. One MIT student per year is chosen to attend a summer session at the Pilchuck Glass School outside Seattle, Washington. The council contributes half of the tuition; Pilchuck provides the balance. The first year's recipient was Helen Lee. This year, the scholarship will go to Chris Laughman.

Susan R. Cohen
Director

More information about the Council for the Arts can be found on the web at http://web.mit.edu/arts/council/.

Arts Communication

In the 13th year of the Office of the Arts, Arts Communication continued to maintain and increase awareness of the arts at MIT both within and outside the Institute by publishing and distributing up-to-date information on MIT arts events and exhibitions; actively promoting arts-related activities, programs and people at MIT; and working with the Admissions Office to inform prospective students about the arts at MIT. Significant developments included the launching of the new MIT arts web site and production of a DVD on the arts at MIT.

Internal (MIT)

The newly designed MIT Arts web site was officially launched, generating praise from all quarters. Postcards announcing the site were sent to the entire campus as well as to individuals off-campus. The Office of the Arts also promoted the web site internally at a Lobby 10 publicity booth, where staff distributed newly produced Arts at MIT Post-It notes and bookmarks, and held a student raffle for new Arts at MIT T-shirts.

Mary Haller, director of Arts Communication, completed production of "Discover the Arts@MIT," a DVD of interviews and performance clips of creative endeavor around the Institute. The piece is to be used for student recruitment and general communication. The first wide-scale broadcast was for commencement guests prior to the start of the ceremony. Initial distribution went to the Creative Arts Council, selected members of the Council for the Arts at MIT, Artist-in-Residence committee members, and contributors to the project.

A new email list was developed especially for those interested in announcements about MIT-related arts, free and discounted ticket offers, and information on special MIT arts events. Largely self-service, folks can subscribe or unsubscribe at any time at http://imap.media.mit.edu/mailman/listinfo/arts-announce/.

Haller hosted an Arts Reception during Campus Preview Weekend. The event, which took place in the Kresge Lobby, included performances by MIT student musicians and gave accepted applicants for the Class of 2006 a chance to meet faculty and current students and obtain information on MIT arts programs and opportunities.

Arts Communication handled the announcements and distribution procedures for a program offering free tickets to concerts by Metamorphosen, held regularly throughout the year. The National Public Radio program "From the Top" also offered tickets to all affiliated with MIT to two of their local tapings.

Lynn Heinemann maintained and publicized arts events on MIT's electronic web-based Events Calendar and maintained the Arts web site, updating calendar listings, publishing each week's *Tech Talk* arts stories and creating new links. The LED sign in Building 16, written and programmed by Heinemann, continues to generate attention with announcements of MIT arts events and activities. Heinemann also continued to produce the weekly "Arts Hotline" (617-253-ARTS) and provided materials for the new "Arts at MIT" kiosk in Lobby Seven.

Arts Communication continued to oversee ArtsNet, which consists of about 90 campus arts representatives.

Haller represented the arts as a member of the Communications Operations Group (COG), Information Group, and Administrative Council.

Student Recruitment and Communication

For the seventh year, MIT's admission application included tear-out postcards for prospective students to use to request information on the arts at MIT and indicate specific arts interests. Postcards were received from 1,008 individuals and a copy of the *Arts@MIT* booklet and a "freebie" flyer were sent to each with a letter from associate provost for the arts Alan Brody.

Tech Talk Coverage

For the 13th year, Arts Communication provided text and images for the Arts Page in *Tech Talk*. Material for 24 feature Arts Pages and eight Month-at-a-Glance Arts Pages (including three two-pagers) was compiled and written by Heinemann and edited by Haller; both worked closely with the staff of MIT's News Office. Month-at-a-Glance Arts Pages were mailed monthly to 624 individuals at their request.

Twenty-eight arts-related feature stories and six arts-related photos-with-captions were published in *Tech Talk*'s general spaces, including one arts story and four arts photo-captions on the front page. Activities and individuals involved in arts were cited five times in the "Awards and Honors" column. Heinemann was the primary writer; other contributors included Christina Jensen (a new staff member shared with the Music Section), Haller, members of the News Office staff and members of the MIT arts community.

Selected Media Attention

The following are some of the headlines publicizing people and projects across the Institute as a result of press releases and publicity efforts initiated by Arts Communication:

> MIT "Great Glass Pumpkin Patch" will dazzle the eye, benefit MIT's Glass Lab—Sept 15-16.
>
> MIT Announces Visiting Artists for Fall 2001
>
> Playwright/director Moisés Kaufman Presents Free Talk at MIT Oct 4
>
> MIT presents Balinese puppeteer Wayan Wija in world premiere of "Shadow Bang," October 12–14

Linda Tillery and the Cultural Heritage Choir at MIT October 21

Filmmaker Isaac Julien to receive McDermott Award from MIT

MIT Media Lab exhibition examines technology's transformation of portraiture

MIT Wind Ensemble premieres "Coyote's Dinner"

MIT Professor John Maeda wins National Design Award from Smithsonian's Cooper-Hewitt

MIT presents American Music Series March 2–May 10, 2002

MIT Hosts Symposium on Michael Frayn's play "Copenhagen"

Other Media Attention

"What kind of project would an artist-in-residence at MIT come up with?" asked ABC *Nightline* executive producer Leroy Sievers. The July 6, 2001, broadcast featured a report by Robert Krulwich on Joe Davis, research affiliate in the Department of Biology and included a look at Davis's paramecium fishing contraption—deep sea fishing equipment mechanically rigged to a drop of pond water. "[Davis] comes up with all sorts of ideas that no one ever thought of before, and then enlists the considerable brain power there to turn them into reality," said Sievers. "I've always believed that part of our job as journalists is to take people places they've never been, and to show them things they've never seen," he continued. "I guarantee you that you have never seen anything like this before."

A feature article in the *Boston Globe Calendar* touted the MIT Chapel as a "small gem ... little known to the public although designed by a once famous architect, Eero Saarinen, in 1955.... Once you're inside, you're in a wondrous place. You hear the lapping sound of invisible water. Outdoor light bounces off the water and comes inside, flickering against undulating walls. You feel isolated from the world around you. No place in Greater Boston feels holier," wrote Robert Campbell.

Playwright/director Moisés Kaufman's residency at MIT was covered in length by the *Boston Herald*'s Terry Byrne, who described an acting workshop class he conducts with MIT students. "The effort, he says, becomes about creating a performance more than simply performing a text," she wrote.

"Greater Boston Arts," WGBH-TV's monthly series on the arts, opens its sixth season in October, 2001, with a profile of Media Lab professor Tod Machover, whom they call an "inventor committed to bridging the gap between music and technology." The segment featured work being done at the Media Lab on interactive musical toys, including rhythmic "beat bug" instruments that communicate without wires to help children create music.

"[Page] Hazlegrove's medium was glass, which she used as expressively and experimentally as any sculptor working in marble or bronze," wrote Christine Temin in a *Boston Globe* review praising the Compton Gallery's "Incandescent Spirit: Page Hazlegrove." "If nature is a force in her work, so are science and technology."

Butoh dancer Min Tanaka earned praise from the *Boston Herald* for his performance to Yoko Ono's music at the List Visual Arts Center. "His extraordinary show at MIT was unquestionably a night to remember," wrote Theodore Bale.

The *Boston Phoenix*'s Jeffrey Gantz included MIT's world premiere performance of "ShadowBang" by Professor Evan Ziporyn in his list of "Moving Performances: The Year in Dance." The collaborative performance by the New York-based Bang on a Can All-Stars and Balinese puppet-master I Wayan Wija "offered us the chance to laugh without irony or guilt for the first time in many weeks," wrote Gantz.

A *Boston Globe* feature, replete with color photos, described the List Visual Arts Center's Student Loan Program in a "Life at Home" column and interviewed students happy to have art in their lives. The article quotes biology doctoral student Sharotka Godzina, who said, "Art is rather important to students at MIT to maintain sanity and help us put things in a broader context."

The List Visual Arts Center's "YES Yoko Ono" exhibition, which came to the List Center as part of a six-city US tour, won the 2000–2001 International Association of Art Critics/USA Awards for best museum show originating in New York City.

Kathleen Goncharov, MIT's new public-art curator, was profiled by art writer/critic Christine Temin in the *Boston Globe*. "Goncharov has arrived amid a flurry of creation as new public pieces are commissioned in conjunction with MIT's 11 major construction projects. The Institute was praised both for its Art on Campus program which allots one percent of a construction project's budget to public art (with a $250,000 cap per project), and for choosing artists through a committee "steered by art-savvy experts."

The List Center's curator, Bill Arning, also was highly visible in the Boston media. *Boston Magazine* featured him in an article on "artist-friendly developments in Boston," calling him "foremost" among curators who know Boston artists. "Curators from around the world call Arning to ask him about the Boston art scene," wrote Stephen Jermanok. "If by chance they're in town, Arning will drive them around to his favorite galleries... 'One of the reasons I took this job is that a large percentage of your audience is students,' [Arning] says. 'If we do a good, edgy show here, something that engages them, then that's a particularly exhilarating position to be in.'"

The *Boston Herald*'s Mary Sherman called "AA Bronson: Mirror Mirror," at the List Visual Arts Center, "less an art show than a meditation on life, loss and perseverance." The *Boston Globe*'s Cate McQuaid wrote, "The show is strong, even brazen, in its unerring challenge to the viewer to face not only mortality but also the cruelty that humans inflict on one another.... It works well not simply because it confronts, but because Bronson provides us, through his reflections, flashbacks, dreams, and hopes, with a soft place to fall."

Broadway-in-Boston came to MIT—first as the cast of "Copenhagen" toured MIT's cyclotron, built when nuclear physics was just being developed, and later to join a panel of renowned physicists discussing "New Thoughts on Interpreting 'Copenhagen,'" moderated by associate provost for the arts Alan Brody. An overflow crowd in Wong Auditorium was attracted by the science, the drama, and by extensive coverage in the *Boston Globe*. The event was organized by the MIT Office of the Arts and Boston's Goethe Institut and engineered by Brian Schwartz of The Graduate Center, City University New York. Documentation of the event resulted in a web site of the proceedings, put together by Lynn Heinemann, at http://web.mit.edu/arts/CopenhagenSymposium.html.

"Many people who go to the MIT Symphony's concerts have probably thought to themselves: This orchestra must have a higher collective IQ than any other," began Richard Buell's *Boston Globe* review of MITSO's Dec. 8, 2001 concert. "Bright, conscientious, spirited performances are the ensemble's proven norm. Saturday night at Kresge Auditorium you also got the distinct impression—not for the first time—that the thornier the assignment, the better this group likes it." Buell also praised Professor Peter Child's "Jubal," which the orchestra performed, as "feisty, inventive, highly colored and purposeful." He continued, "In a juster world, 'Jubal' would immediately be making its way onto the major-league big-orchestra circuit."

Lloyd Schwartz of the *Boston Phoenix* called the MIT Symphony Orchestra's May 11 performance of Krzysztof Penderecki's Viola Concerto, with guest artist Marcus Thompson, "one of the most stirring events of the season." The review praised Thompson's sound as "full, rich, and extremely complex; he has a rhythmic backbone, an edge, even when his tone is most gorgeous and velvety" and said, "Anzolini ... guided the superb MIT players through the tricky Stravinskyan rhythms, the emotional swerves, the kaleidoscopic changes of color and texture."

In addition, MIT arts faculty received media attention for their work off campus, including:

- Professor Evan Ziporyn for his latest CD, "This Is Not a Clarinet"
- Music and Theater Arts lecturer Laura Harrington for her play "Hallowed Ground"
- Professor Ellen Harris for her provocative new book *Handel as Orpheus: Voice and Desire in the Chamber Cantatas*
- Institute Professor John Harbison for the Metropolitan Opera's revival of his opera "The Great Gatsby"
- Assistant professor Michael Hawley of the Media Lab for his top prize in the Van Cliburn Foundation's Third International Piano Competition for Outstanding Amateurs, held in Fort Worth, Texas
- Professor Marcus Thompson for his last-minute role as substitute violist with the Lydian String Quartet
- Musician and film composer Jamshied Sharifi (S.B. 1983) as one of a dozen artists who created and recorded new works for National Public Radio's "A Requiem Soundscape" commemorating the one-month anniversary of the 9/11 tragedy
- Professor Anzolini for his guest appearance with the Choral Arts Society of Washington, DC
- Professor Tod Machover for his opera "Resurrection" (libretto by Lecturer Laura Harrington)

Mary L. Haller, Director
Lynn Heinemann, Administrative Staff Assistant

More information about the Office of the Arts can be found on the web at http://web.mit.edu/arts/.

Special Programs

Special Programs began its twelfth year of developing diverse programs with MIT departments.

Special Programs Sponsorship

In addition to Institute support, Special Programs received support from the Council for the Arts at MIT, the William L. Abramowitz Fund, the Ida Ely Rubin Fund for Arts and Technology, the Alan H. Katzenstein Memorial Fund, the Peter DeFlorez Fund for Humor, the John S. and James L. Knight Foundation, the List Visual Art Center, the LEF Foundation, and the MIT-Italy Program.

Artist-in-Residence Advisory Board

In its fifth year, the Advisory Board under the leadership of Steve Memishian (G) '70 welcomed new membership and was reminded of its mission:

The Artist-in-Residence (AIR) Program in the MIT Office of the Arts develops innovative opportunities for students and other members of the MIT community to interact with leading artists from around the world. The Program integrates artists into MIT's existing curricula in the arts and humanities, science, engineering, and management. It also works with faculty to develop curricula around the artist's visit to encourage creative thinking and expression within the MIT educational experience, while broadening

students' artistic experience. Consistent with MIT's overall mission, the program recognizes and actively engages issues of diversity as a vital part of the cultural life of MIT.

Meetings were held on September 24, 2001, and April 29, 2002. The February 2002 meeting was cancelled.

Artist-in-Residence Advisory Board Subcommittees

The William L. Abramowitz Program became program partners with Comparative Media Studies. A Faculty Subcommittee including Professors Henry Jenkins, Ellen T. Harris, Evan Ziporyn and acting director Michael Ouellette was formed to develop long-range plans. Julie Taymor, director and stage designer, and the Pulitzer Prize–winning cartoonist Art Spiegelman were nominated, along with other celebrated artists such as Mark Morris, Ang Lee and Jim Schamus, Don Byron, collaborators Nick Bantock and Alex Mayhew, and Ming Cho Lee. The long-range plan will provide greater flexibility in development and scheduling.

The Ida Ely Rubin Artist-in-Residence Fund and the List Visual Art Center sponsored Paul Pfeiffer, digital video and mixed media installation artist, from September 18 to 20, 2001. Programs were developed with the Media Lab, Comparative Media Studies, the Visual Arts Program, and the Athletics Department. Pfeiffer investigated three-dimensional printing with Professor Michael Cima and his students in Materials Science and Engineering and developed future engagements with principal research scientist Michael Bove in the Media Lab. A Fall 2002 program is planned.

The Ida Ely Rubin Subcommittee, including Ida Ely Rubin and Claire Montgomery, executive director of Location One, made plans to meet at Location One along with Jane Farver, director of the List Visual Art Center, and Maureen Costello, director of Special Programs, to review and select the next visiting artist in Arts and Technology.

In collaboration with Comparative Media Studies and with MIT support from the Alan W. Katzenstein Memorial Fund, the Advisory Board nominated filmmaker, director, and writer Kasi Lemmons for a program to be held on November 7, 2002. The Advisory Board nominated choreographers Eiko & Koma for an April 3, 2003, program.

School of Humanities, Arts, and Social Sciences

The Theater Section, the Visual Arts Program, and the Women's Studies Program supported Conway & Pratt Projects, Inc's visual and theatrical installation "A Woman's Work Is Never Done: a house of curiosities." A recruitment party was held where the artists presented their work to students and communicated possibilities for student involvement. The installation ran from September 19 to October 14, 2001, at 71 Amory Street in Jamaica Plain. A UROP student assisted prior to and during the open hours. Council for the Arts scholars visited the installation on the evening of October 12. Six courses from the Women's Studies Program involved their students. "A Woman's Work Is Never Done: a house of curiosities" was presented in collaboration with The Bostonian Society, Women's Educational and Industrial Union, and the LEF Foundation New England.

The 2001 William L. Abramowitz Program brought Moisés Kaufman, playwright and artistic director of the Tectonic Theater Company, to MIT from October 2 to 4, 2001. Preparation for this program included the distribution of copies of Kaufman's "Gross Indecencies: The Three Trials of Oscar Wilde" and "The Laramie Project," which were also made available to the public, all MIT students, and members of the Residency Advisory Board. "An Evening with Moisés Kaufman" was held in Wong Auditorium. Special guests included Kenneth and Nira Abramowitz.

A significant international collaboration was realized with "Shadow Bang, Balinese Puppetry Meets New Music," with Professor Evan Ziporyn, Balinese puppeteer I Wayan Wija, and the performance ensemble Bang on a Can All-Stars. The world premiere of "Shadow Bang" took place at MIT on October 9, 2001, in the Kresge Little Theater. Discussions with the artists were held after matinees and evening performances. Artists participated in workshops with Gamelan Galak Tika and students in Music and Theater Arts.

Sergio Escobar, administrative director of Milan, Italy's Piccolo Teatro, was invited by associate provost for the arts Alan Brody and Theater Arts professor Janet Sonenberg to offer a public discussion on "Science and the Theatre" and work with students in Theater Arts. Additional sponsorship was provided by the MIT-Italy Program.

School of Architecture

The 2001 Eugene McDermott recipient Isaac Julien, filmmaker and installation artist, received an award at the DeCordova Museum in Lincoln in October 2001. He returned to MIT in the spring to work with Visual Arts Program professor Joan Jonas. Council for the Arts member Marjorie Jacobsen introduced Mr. Julien at a screening of "Badassed Cinema," a commentary on the Blaxploitation films of the early 1970s. Council for the Arts scholars and Comparative Media Studies graduate students attended the screening, a reception at Senior House, and dinner at Legal Sea Foods with the artist.

In Media Arts and Sciences, Diane Willow, sound and environmental artist, completed her final year as artist in residence in collaboration with associate professor Mitchel Resnick of the Media Lab's Epistemology and Learning Group. "SEAt," with new six-foot drumheads, and "Clearing the Air Project," a sculpture featuring three eight-foot coils with sensors that respond to sound waves and harmonic resonance, will be sited in Fall 2002.

School of Science

Science photographer Felice Frankel completed her final year with Residence Program support and will continue as a science researcher.

School of Engineering

Peter Houk, artistic director of the MIT Glass Lab, presented the history of glass blowing to the AIR Advisory Board on September 24, 2001. Mr. Houk's residency supported his work at the MIT Glass Lab. Mr. Houk and his colleagues implemented The Great Glass Pumpkin Patch on the Kresge Oval.

Arthur Ganson, kinetic sculptor, withdrew from the Residence Program.

List Fellowship Program in the Arts

The List Foundation Fellowship Program in the Arts for students of color continued with support from the John S. and James L. Knight Foundation.

Carolyn Beth Chen '02 and Melissa Edoh '02 received fellowships to support digital videography and training in the Sabar drumming and Gumboot dance traditions of Senegal. "Story@MIT" will recruit volunteers for Ms. Chen's summer project. Programs for Fall 2002 and IAP were developed.

Talia Kingsbury '01, a mechanical engineering and creative writing graduate, will publish a chapbook, "Origin/Destino." A reading will be held in Killian Hall on September 13, 2002.

Vince E. Carballo '02, mechanical engineering, installed a mixed-media installation entitled "Lost Sons" in the Wiesner Gallery in December 2001. Rigel Stuhmiller withdrew from the program.

Several changes were made in the List Program:

- It will be available to sophomores and juniors only
- A fixed one-year schedule was established
- An e-mail list, artsfellowship@mit.edu, was created to make the program more accessible
- Two informational meetings for prospective applicants will be held in September.

Staffing Changes

Amy Sanford, administrative staff assistant, moved to the Graduate Admissions Office, and Meredith Cutler was hired. The job of administrative staff assistant was re-evaluated to include coordination of the Freshman Arts Seminar Advising Program. A senior staff assistant position was created.

Maureen Costello finished as director of Special Programs in June 2002.

Maureen Costello
Director

More information about Special Programs in the Office of the Arts can be found on the web at http://web.mit.edu/arts/special_programs/.

Dean, School of Architecture and Planning

The School of Architecture and Planning deals with a far wider range of fields and issues than its name might suggest. In addition to the Department of Architecture (the oldest such department in the country), and the Department of Urban Studies and Planning, it houses the Program in Media Arts and Sciences, the Media Laboratory, the Center for Real Estate, and the Center for Advanced Visual Studies. The cross-disciplinary research and education occurring among these units enables faculty and students to address all aspects of the human environment.

During academic year 2001–2002 the School saw a number of particularly exciting developments in faculty appointments, initiation of new research and teaching ventures as well as continued efforts to improve current course offerings, and in improvement of physical facilities. This report will present selected highlights of these achievements while reports from the School's departments, programs, laboratories and centers will provide additional information about the past year.

Faculty

Associate dean and Ford professor of urban development Bernard Frieden retired this year and is now Ford professor of urban development emeritus. The School appointed associate professor of architecture Terry Knight associate dean beginning in January 2002. In addition to teaching and research, her responsibilities will include monitoring and implementing new school-wide faculty diversity initiatives, school outreach and communication efforts, and web-based educational technology projects.

In the Department of Architecture structural engineer John Ochsendorf will join the Building Technology group in July 2002. Caroline Jones will join the faculty as a tenured associate professor of the history of art. John Fernandez was named to the Class of 1957 Career Development Professorship and Wendy Jacob was named to the Class of 1947 Career Development Chair, both for a three-year term. Professor Edward Levine, the first director of the Visual Arts Program, retired this year.

In the Program in Media Arts and Sciences (MAS) Cynthia Breazeal and Chris Csikszentmihályi were both appointed assistant professor of media arts and sciences. Associate professor Justine Cassell received tenure this year.

After eight years as department head in the Department of Urban Studies and Planning, Professor Bish Sanyal is stepping down. He is succeeded by Professor Larry Vale, a Margaret McVicar Faculty Fellow and associate head for the past two years. Ford Professor Langley Keyes has been appointed associate department head. Professor Vale was promoted to full professor this year. Assistant Professor Dara O'Rourke was selected to hold the Mitsui Career Development Professorship. Professor David Geltner, from the University of Cincinnati, was appointed to replace departing associate professor Timothy J. Riddiough. He will be teaching courses for the Center for Real Estate (CRE) program.

Institute Professor emeritus Gyorgy Kepes, who came to MIT in 1946 as associate professor of visual design and became a full professor in 1949, died this year. He founded the Center for Advanced Visual Studies (CAVS) in 1967 and served as its director until 1972.

Increasing the diversity of our faculty and students continues to be an important goal for the School. Over the past few years, with help from the provost's special programs, we've had great success in attracting women and minorities to the School.

In the spring of 2000, a Committee on Women Faculty was constituted at the request of the dean and provost. Its members included six senior faculty—two each from the Departments of Architecture, Urban Studies and Planning, and the Program in Media Arts and Sciences. Through the use of data collection and structured interviews, the committee was charged with preparing a report assessing the status and equitable treatment of women faculty in the School. The committee found inequities in all four parts of the study—in numbers, salary, recognition and resources, and experience. The focus of the report was on the status and treatment of women, however, from their interviews the committee found problems of concern to men and women faculty alike. Quality of life issues (for example, excessive work demands, and difficulties balancing work and family responsibilities), mentoring, and the distribution of incentives were issues important for both men and women. In addition to suggesting a separate initiative to address issues affecting all faculty, the report included recommendations for improving the status and equitable treatment of women faculty, and for increasing the proportion of women faculty in the School. Work in these areas is being continued through a number of newly formed committees.

Space

Construction documents for the new Media Laboratory expansion, designed by world-renowned architect Fumihiko Maki, have been completed.

The most recent phase of the School's master plan—the renovation of offices, project rooms and the Computer Resources Labs of the Department of Urban Studies and Planning—was completed last fall.

The renovation of the graduate student studio spaces of the Visual Arts Program, providing much needed upgrading and added security measures, were completed in time for the fall term.

Educational Initiatives

Departments throughout the School continue to develop their undergraduate and graduate programs in new directions, as described in the departmental sections of this report.

The ArchNet project, an initiative of particular interest, is an Internet-based network intended to be a resource and online community for scholars and design and planning professionals in developing countries, with a special focus on the Islamic world. This project is a collaboration between the Aga Khan Trust for Culture, the School of Architecture and Planning at MIT, Harvard University, and six partner schools in Egypt, Lebanon, Turkey, Pakistan, India, and Malaysia. Currently over 5,000 online subscribers from more than 120 countries are utilizing ArchNet's resources and virtual workspaces. Detailed information can be found at http://archnet.org/.

The goal of StudioMIT, another new project in the School, is to design, implement, and maintain a comprehensive web-based environment that supports the community of students, staff, faculty, alumni and prospective applicants of MIT's studio-centered professional degree programs.

Events and Awards

Each year faculty and students of the School receive numerous honors in recognition of their research and service, many offered by the School, the Institute, professional societies, as well as national and international recognitions. This year was no exception. The reports of the School's departments, laboratories, centers, and programs make note of many of these awards. Several especially notable awards deserve additional mention here.

This year in the Department of Architecture, Professor Krzysztof Wodiczko won a major competition for a Memorial to the Abolition of Slavery in France. Assistant Professor J. Meejin Yoon was named a New York Architectural League Young Architects winner. Among the many awards received by students in the department, Junko Nakagawa and Daniel Steger received the Francis Ward Chandler Prize for achievement in architectural design. Heinz Isler delivered the fifth Felix Candela lecture. The Arthur H. Schein Memorial Lecture was given by Sir Nicholas Grimshaw. The Architecture Lecture Series included distinguished guests Jane Thompson, Takashi Yamaguchi, Peter Eisenman, Brian Mackay-Lyons, Jesus Aparicio, Rick Joy, James Stewart Polshek, and Taina Rikala, Vito Acconci, Peter Wheelwright, Mario Coyula-Cowley, Juhani Pallasmaa, Nicholas Adams, and Rafael Moneo. In addition, the department sponsored a lecture series and related activities on "September 11 and Aftermath," coordinated by Helene Lipstadt.

In the Program in Media Arts and Sciences, associate professor John Maeda was honored with the "special award" of the Mainichi Design Prize for 2001. The award is Japan's oldest and most prestigious design award. He also received the 2001 National Design Award from the Smithsonian's Cooper-Hewitt National Museum. Assistant professor Scott Manalis was selected by *Technology Review* as one of the 100 "brilliant young innovators—all under 35—who will have a deep impact on how we live, work, and think in the century to come." Associate professor Joseph Jacobson was one of eight recipients of *Discover* magazine's 2001 Award for Technological Innovation.

In the Department of Urban Studies and Planning, Professor Anne Spirn received the 2001 International Cosmos Prize, which recognizes achievements in promoting the concept of "harmonious coexistence of nature and mankind." The Lewis Mumford Prize of the Society of American City and Regional Planning History was awarded to Professor Robert Fogelson. Associate professor Diane Davis has been named one of sixteen leading researchers by the Carnegie Scholars program. Student Liou Cao won Best Student Paper at the 2001 Urban and Regional Information Systems Association Annual Conference. City Design and Development faculty and students organized a special colloquium and seminar entitled "The Resilient City: Trauma, Recovery, and Remembrance" that brought together scholars and urbanists to consider the meaning of the September 11 tragedy by examining historical precedents for rebuilding in cities world-wide. The Environmental Policy Group (EPG) organized and hosted a number of conferences and workshops, including the continuing "Civic Environmentalism Roundtable." For the ninth year in a row, EPG faculty chaired the International Programme on the Management of Sustainability, held each year in the Netherlands to assist 40 governmental and non-governmental staff from the developing world in their efforts to implement Agenda 21. The Housing, Community and Economic Development group continued to get strong speakers, active in Boston planning issues, for the Wednesday luncheons. The faculty in the International Development and Regional Planning group are involved in nine major multi-year research and teaching projects. For example, in one project, Professor Bish Sanyal is leading an effort to establish a Learning and Education Alliance and Resource Network (LEARN) as a way for universities to influence urban poverty alleviation policies in developing countries.

The Center for Real Estate hosted a meeting in November for corporate supporters, current students, faculty, and, for the first time, members of the public. The topic of the symposium was trends affecting the commercial brokerage sector of the industry. In May the spring symposium, "Smart Growth: What's Behind the Rhetoric?," examined the pros and cons of growth management. Robert Danzinger, retired chairman of Northland Investment, led the popular Real Deals speaker series for the sixth year in a row.

At the Center for Advanced Visual Studies, director emeritus Otto Piene is organizing center documentation for 1968 to 1994 as a preparation for a documentary volume. Fellow Seth Riskin was invited to present "Light Dance" performances on seven occasions, including a new piece for the Kepes Memorial Event at Kresge Theatre, MIT, in June.

The Ralph Adams Cram Award for outstanding interdisciplinary work at the master's level was presented to Omar Khan (SMArchS, 2001). The School received a number of outstanding proposals for the Lawrence B. Anderson Award, so the review committee decided to present three awards. This year's recipients were Nina Chen, Murat Germen, and Jennifer Gilbert. The Harold Horowitz (1951) Student Research Fund was awarded to five individuals this year: Zhang Yan, Malo Hutson, Joao Rocha, Celina Su, and the team of Matthew Pierce and Andrew Marcus.

William J. Mitchell
Dean
Professor of Architecture and Media Arts and Sciences

More information about the School of Architecture and Planning can be found on the web at http://sap.mit.edu/.

Department of Architecture

This is a Department of Architecture with the professional Master of Architecture degree program as its core activity. The faculty includes architects, urbanists, building technologists, historians of art and architecture, artists, and various specialists in areas of architectural research. The presence of this entire range of faculty is premised on assuring a professional program of both depth and breadth. The strength and well being of the Master of Architecture program is fundamental in maintaining and enhancing our position as one of the world's most respected professional schools of architecture.

The department is quite unusual in, first, including the many disciplines of our faculty within the department, and then, still more significantly, creating the opportunity for each discipline to have specialized advanced degree programs. We incorporate outstanding research and teaching programs in each of these groups: Building Technology; History, Theory and Criticism; Visual Arts; and the internally differentiated Architectural Design group. Under the last rubric, beyond the obvious attention to architectural design, are our programs in urban design, computation and design, shape grammars, and design technology. We have been gratified to see excellent design work by our undergraduates in recent years. Notable strengths of the department that cut across the discipline groups are our devoted teaching, the grounding of architecture in both social and material issues, interdisciplinarity, and the remarkable internationalism of faculty, students, teaching and research.

The discussion below is organized by discipline group, followed by individual topics that cross discipline areas.

Architectural Design

The statement below was prepared for the accreditation of our professional architectural design degree, but also emphasizes the interconnecting roles of all discipline areas in the department.

Our Goals in Architectural Education

It is a commonplace that new theories and new technologies are changing our conception of what architecture can do and how architects conceive their tasks and accomplish them. The unique position of the MIT Department of Architecture is that we survey the development of theory from a decades-old departmental commitment to viewing such developments through the long lens of the history of criticism. We also view technology within an Institute which for a half-century has profoundly shaped and investigated technology's role in society. So we are open to—indeed are enthusiastic about—new technologies and theories. But we also feel impelled to test the results of our designing against long-held social and environmental values. As we embrace new conceptions of architecture, we demand of ourselves that our designs have the qualities of space, light, air, tectonic soundness, and place that allow for appropriate, even poetic, inhabitation.

During 2000–2001 a committee broadly representing the department discipline groups re-organized the MArch curriculum. Notable emphases of this new curriculum are increased emphasis on design, greater integration of subjects from different disciplines taken in the same term, and a stronger model for the selection and development of "concentrations." In the fall of 2001, entering graduate students took part in a program that integrated all their subjects, with the architectural design studio at the center. While any new approach requires further development, this experiment was deemed highly successful.

Beginning students (undergraduate and graduate) build up modeling and drawing skills (conventional and digital) in subjects conceived for those purposes and by focusing those skills on an expanding range of ideas that the students must synthesize in their studio projects. The first semester of Level II extends the core studio sequence for graduates and qualified undergraduates with a focus on tectonics—the making and the resultant expression of construction and architecture. We continue the core sequence into the spring term of Level II. During that same term, MArch students develop a "concentration," a particular field of inquiry, which they continue to pursue through closely focused design "workshops" and coursework in this and other departments.

Having "graduated" from the core sequence, MArch students in Level III choose that combination of diverse studio offerings which best meets their individual needs and desires. The insights gained in these studios and the concentration culminate, in the final semester, with the MArch students' theses.

Special opportunities for project-generated student travel are a continuing strength of the department. Shun Kanda again led an extended summer study trip in Japan. This year the fall urban design studio was set in Cambridge, England, with sponsorship from the Cambridge/MIT Institute. Jan Wampler and Dennis Frenchman are currently conducting their biennial summer workshop at Tsinghua University in Beijing. Reinhard Goethert led a group of students to Venezuela. Thanks to the generosity of alumni (Ann Macy Beha, Louis Rosenberg, John Schlossman), students also pursue individual research studies in the United States and abroad.

The Themes We Pursue to Accomplish Our Goals

A hallmark of studio education at MIT is that instructors propose to their students not merely a project but a process by which that design might be accomplished. Our faculty

employ a shared set of themes as vehicles for advancing their pedagogies. Here are those themes, not imposed by departmental fiat, but observed and endorsed by all of us in mutual consultation.

Tectonic Expression. We find among ourselves a poetic and pragmatic interest in how materiality, the manner of construction, and the means of managing natural forces (gravity, climate, airflow...) might be expressed.

Light and Inhabitation. We feel that attention must be paid to the capacity of light to transform and model space in ways appropriate to a range of human activities and emotions.

Building Community. We believe that respect must be accorded to the identity and social needs of inhabitants of places, both to establish private territories for them, and to enhance their abilities to participate in the public realm.

Cultural Heritage. We respect the value of cultural difference, and we seek strategies that preserve the legacy of artifacts and customs from the past while addressing the pressures and opportunities of the present.

Urbanism. We are acutely aware of architecture's ability to contribute spatially, symbolically, and functionally to the shared but divergent social and economic life of cities.

Engaging the Landscape. We understand the impact of buildings as material and experiential extensions of the land. We thus pay particular attention to the impacts that designed environments have on natural systems-and vice versa.

Sustainability. We feel a concern for the conservation of natural resources, not just in terms of the efficiency of the buildings we design and the practices our buildings foster among their inhabitants, but in terms of larger practices like settlement and transportation.

Virtual Environments. We are fascinated by the use of digital media to study and represent physical spaces and phenomena. We recognize the opportunity such media afford to design sites, software, and protocols that may foster a sense of inhabitation, of place, in cyberspace.

Planning Committee

A departmental planning committee met throughout the spring term. We have already begun to act on its three primary proposals.

- The significant improvement already realized with our undergraduate program should first receive full recognition and then be enhanced. We will give attention to every aspect of the undergraduate program, from improved advertising and direct attention to the admissions program to further development of our optional undergraduate thesis.
- Enhancement of design within our post-professional degree and our faculty and student research programs.
- Administrative reconstruction to address the two initiatives. This has begun with the appointment of Associate Professor Ann Pendleton-Jullian as associate head, a position with special responsibility for the central design component of the MArch program.

Faculty Matters

Ann Pendleton-Jullian was on leave spring term. Paul Lukez was on leave fall term. Michael McKinnell also was on leave for the year. Anne Spirn received the 2001 International Cosmos Prize, which recognizes achievements in promoting the concept of "Harmonious Coexistence of Nature and Mankind." Retired professor of architecture Imre Halasz was named a fellow of the American Institute of Architects. J. Meejin Yoon received a HASS grant for her project "Between Bodies and Selves." Yoon also was named a New York Architectural League Young Architects winner.

Visitors

The noted Indian architect and MIT alumnus Charles Correa continued his annual one-term position teaching in the urban design studio with Julian Beinart and John de Monchaux. We had an excellent cast of visiting studio faculty including Marlon Blackwell, Carol Burns, Brian Healy, Alan Joslin, Valeria Mazarakis, and Hubert Murray. John Gero and Mary Lou Maher received one-year visiting appointments beginning in the spring, to teach in the area of computation and design. Francis Duffy began a three-year appointment as visiting professor to participate in the workplace-related research and teaching led by William Porter.

Admissions

Students in our professional MArch degree program are admitted at two levels: those (Level I) who come from undergraduate studies in other areas and those (Level II) who come from undergraduate programs in architecture and thus receive one year of advanced standing in our three-and-a-half year graduate program. For the past two years our admissions have been consistently strong. In 2001 we significantly exceeded our target enrollment without going to our waiting list (37 acceptances from 70 admits with a goal of 28). In 2002, we reduced our goal (to compensate for the heavy 2001 enrollment) and our admittances. The result was 28 acceptances from 61 admits, with a goal of 26. Students applying and admitted at Level I come almost wholly from the most prestigious private colleges and universities. As usual our principal competitor was Harvard, with Yale strengthening in recent years. Most of the students admitted at Level II come from major public universities, here and abroad. Harvard is the main competitor here as well.

Research

Research interests of faculty in architectural design include sustainability (Andrew Scott); shape grammars (George Stiny); computational synthesis and supporting digital technologies (Terry Knight); "Enterprising Places," a study of how to support spin-offs of university-industry collaborations (William Porter and others through the Cambridge/MIT Institute); digital technologies and their impacts on architecture, urban design, and urban life (William Mitchell); computational representation and modeling of architecture (Takehiko Nagakura); computational and physical environment to support collaboration among geographically distributed groups and individuals (William Porter); design in developing countries (Jan Wampler, Reinhard Goethert); urban design (Charles Correa, Michael Dennis, Julian Beinart); urban morphology (Paul Lukez); the American landscape (William Hubbard); cities and landscape, photographic representation of landscape (Ann Spirn); computer-enhanced housing of the future—House_n and Changing Places (Kent Larson); materials and fabrication methods as generators of new design possibilities (Yoon). Research has been well represented in publications, including books, book chapters, and journal articles, and news articles.

Design and Computation

The Design and Computation group, incorporating Design Technology, continued to build its unique, wide-ranging strengths from foundational work in computation theory to practical applications of computation in architectural design to inquiries into the design process and the impact of digital technologies on society and space. The group is increasing in faculty size and efforts are underway to enhance the visibility and prominence of the area, with a proposal to establish a separate discipline group within the department, and to increase its potential contributions to the professional program. The group sponsored a lecture series, hosted two internationally distinguished visitors, and mentored a talented group of graduate students. Plans are underway to launch a new international conference series on Design Computing and Cognition. A search is being conducted for a junior-level faculty member who focuses on applications of research to design at the frontiers of design practice. Lawrence Sass, recently appointed as assistant professor, will add to the current faculty's range of work with his focus on the emerging area of digital fabrication.

Architectural Practice

Established practices are conducted by Julian Beinart in association with Charles Correa, Michael Dennis, and Michael McKinnell. Smaller practices include those of Fernando Domeyko, Shun Kanda, Paul Lukez, Ann Pendleton-Jullian, Wellington Reiter, Andrew Scott, Peter Testa, and Jan Wampler.

Professional Associations

The department has established special relationships with several international firms considered among the most notable in the world and continues to explore additional opportunities. Students were accepted for internships or workshops with Renzo Piano Workshop in Paris (Jason Hart), Behnisch and Partner in Stuttgart (Pamela Campbell), Glenn Murcutt Workshop in Australia (Jeff Taylor), "Ghost Workshop" with Bryan McKay-Lyons in Nova Scotia (Josh Barandon), and Takenaka in Japan (Aaron Greene).

Institutional Association

The department welcomed two graduate exchange students from the University of Cambridge for the academic year and two undergraduate exchange students from The Technical University of Delft for the fall term.

Building Technology

The Building Technology (BT) group continues a strong research record and specialized graduate instruction. Critical reflection is being directed toward enhanced teaching both at the undergraduate and professional architecture levels.

Program Activities

John Fernandez was the principal designer of the September 11 memorial at MIT. He was awarded a HASS Award from the Institute for a proposal titled "The glass wall—a search for structural and expressive potential in a laminated glass composite" and presented papers at the National ACSA Technology Conference and the High Performance Structures and Composites Conference. The BT group is continuing its collaboration with Cambridge University on sustainable buildings and natural ventilation as part of the Cambridge/MIT Institute (CMI). Several MIT students spent time at a large commercial site in the UK carrying out detailed monitoring of a new large commercial building. They were able to show several steps to substantially reduce energy consumption. Cambridge University and MIT faculty jointly conducted a course at MIT in June for designers and technologists on sustainable building design. Andrew Scott conducted a design studio around one of the main CMI projects, a new headquarters for the BP Aberdeen operation. The BT group also continued their joint program with the Alliance for Global Sustainability, Chalmers University and ETH, along with Tsinghua University. In the newest phase they are helping to prepare sustainable guidelines for Chinese residential buildings. The BT group is also continuing its work with Harvard University on the new portal Buildingenvelopes.org. MIT has developed some real-time tools that designers can use to evaluate the performance of sustainable building designs. John Fernandez organized a year-long lecture series on "The Science, Economics

and Policy of Sustainable Strategies." Speakers included Anne Spirn, Andrew Hall, Daniel Schrag, Ronald Prinn, Vivien Li, Linda Haar, Stephanie Pollack, Nicolas Ashford, Kenneth Wright, and Ruth Wright.

Faculty Matters

Leon Glicksman was on leave in the spring term working on the CMI project in Cambridge, UK. Qingyan Chen left MIT at the end of the academic year to accept a position at Purdue University. John Fernandez was named to the Class of 1957 Career Development Professorship for a three-year term commencing 1 July 2002. Barry Webb, noted Australian lighting designer, and Carl Rosenberg of Acentech teamed again to teach lighting and acoustics. Austin Parsons also taught again in the fall term as a visiting assistant professor. Natalia Cardelino and David Whitney were lecturers in the fall and spring, respectively. John Ochsendort, appointed a year ago and having completed his PhD at Cambridge University, has already arrived to begin the 2002–2003 academic year.

Institutional Association

As noted under research, BT is involved in a long-term program under the Cambridge/MIT association. Research work continues with Tsinghua University and members of the Alliance for Global Sustainability.

History, Theory, and Criticism

The faculty and graduate students of the History, Theory, and Criticism (HTC) group continue a strong record of research, conference participation, and publication. Graduates of the advanced degree programs continue to receive excellent teaching positions throughout the world.

Program Goals

Five PhD and two SMArchS degree candidates graduated over the academic year and two PhD candidates successfully defended their dissertations. Fifty-four total applications (46 PhD, eight SMArchS) were received. Four PhD candidates accepted enrollment for fall 2002. A continuing program goal is to update the primary HTC seminar room with connections to the MIT web systems and access to the Rotch Visual Collection. It is important to the future of HTC that it have a visual resource for teaching and study equivalent to those being developed at other great institutions where architectural and art history is taught. This will require acquisition of a digital cataloguing system and investment in staff time to create a database of images to match the standard of the excellent slide collection built up over the department's long history.

Program Activities

The HTC Forum lecture series hosted Hilde Heynen, Daniel Abramson, Natalie Jeremijenko in fall 2001; and Elizabeth Grosz (co-sponsored with Harvard University), Richard Diesnt and Vanessa Schwartz (both co-sponsored with Comparative Media Studies), and Adnan Morshed in spring 2002. Arindam Dutta organized a fall film series, "The Aesthetics of Decolonization," and a spring film series, "New York City in Film," that engaged students from across the department. Faculty, students and an alumnus contributed to *Thresholds*. Mark Jarzombek with PhD candidate Juliana Maxim organized a conference on East European art and architecture in October 2001.

Faculty Matters

Mark Jarzombek was on leave in the fall term. Caroline Jones will join the faculty next year as an associate professor of the history of art with tenure. David Friedman received a HASS grant for his "Urban Design and Topographic Survey." Heghnar Watenpaugh joined the faculty as an assistant professor of the history of architecture and Aga Khan career development professor. (See also entry below for Aga Khan Program.) Visiting faculty were Helene Lipstadt and Robert Haywood for the academic year; John Rajchman, Stuart Steck and James O'Gorman for the fall term; and Henry Millon for the spring term. Arindam Dutta was named to the Blackall Career Development Chair in Architectural History for a period of three years.

Research and Publication

Research interests of the faculty include architecture and urbanism of modern Europe and America (Stanford Anderson and Mark Jarzombek); of Europe and its colonial enterprises (Arindam Dutta); modern European art (Erika Naginski); art/architectural theory and epistemology (Anderson, Jarzombek, Naginski); urbanism in pre-modern Europe, late medieval and Renaissance architecture (David Friedman); medieval and modern Islamic architecture and urbanism (Nasser Rabbat); preservation, pre-modern Islamic cities, gender and architecture (Watenpaugh); and historiography of art and architecture (all).

All members of the group regularly contribute to important journals in their fields and to edited works. Books include Stanford Anderson's *Peter Behrens: 1868-1940* (MIT Press, 2000), which was published in an Italian edition (Milan: Electa, 2002) with significantly increased illustration. He received grants from the Graham Foundation for the publication of essays arising from conferences on Eladio Dieste and Alvar Aalto. Mark Jarzombek was volume editor for *Twentieth-Century Architectural Theory* (London: Harvey Miller, 2002). He received grants from the Graham Foundation for his book project *Global Architecture* and for the publication of the proceedings of the East European Art and Architecture conference.

Student Financial Aid

In recent years, and culminating two years ago, HTC had fallen far behind its traditional competitors (Princeton, Harvard, Columbia, and Cornell especially) in financial

aid to doctoral students. In the last two years, thanks to the collaboration of the provost and dean, our financial aid offers are competitive. With this support, HTC PhD admissions were once again very successful. Doctoral students entering their non-resident research stage continue to win prestigious external research grants. The employment record of our graduates also remains impressive, with recent appointments at Columbia, Harvard, Illinois Institute of Technology, Princeton and Yale.

As for all units of the department, providing adequate student financial aid has been and remains a crucial issue. In HTC this primarily means offering financial packages that will attract the best candidates for the PhD program.

Visual Arts

The Visual Arts Program (VAP) continues to develop its unique program addressing the relation of artistic practice to new media, performance, architecture, urbanism, and related questions of sociopolitical content. VAP supports the undergraduate education curriculum of the Institute and also conducts a small graduate program. Its faculty includes a remarkable group of outstanding artists, positioning us to compete as one of the distinguished schools for contemporary artistic production.

Faculty Matters

Dennis Adams, director of the Visual Arts Program, was on leave in 2001–2002. Wendy Jacob served admirably in that role. Jacob was named to the Class of 1947 Career Development Chair for a period of three years. Julia Scher was on leave in 2001–2002. Antonio Muntadas, a fellow of MIT's CAVS and an internationally renowned artist working on the boundaries between new media, art, architecture and advertising, was a visiting professor. Joe Gibbons, a nationally renowned video maker, was appointed as a lecturer for the year. Lecturer Reiner Leist taught photography, including a class reserved for MArch students. Visiting lecturer Christine Tarkowski from the Art Institute of Chicago taught the new architecture/visual arts subject specially reserved for MArch students. Tarkowski works on the relationship of graphic design and architecture. Of special significance was the retirement this year of Professor Edward Levine. Levine was the first director of the Visual Arts Program. His early efforts resulted in the program's enjoying an unusually vital and renowned arts faculty.

Faculty Activities

While on leave, Dennis Adams worked on public projects in New York, Baltimore and Utrecht. Three faculty—Krzysztof Wodiczko, Dennis Adams and Antonio Muntadas—participated in Arte Cidade, a major public art festival in Sao Paulo, Brazil. Wodiczko was represented in the Yokohama Triennial (summer 2001) and won a major competition for a Memorial to the Abolition of Slavery in France. He will be taking the spring semester off next year to work on the memorial. Wendy Jacob's work "Sleepers" toured museums in Germany as part of an exhibition on the history of kinetic art. She also showed work in exhibitions in New York, Chicago, Canada and France. Joan Jonas created an installation and performance for Documenta IV (summer 2002). Documenta, a summer-long event that occurs every five years in Kassel, Germany, is one of the world's best-known and established exhibitions of contemporary art. Along with List Visual Arts Center director Jane Farver, Jonas co-curated the exhibition "Tele-Journeys" at the List gallery (spring). The exhibition, which includes video, film, sound, and installation, focuses on young artists from around the world who are working in Western Europe. Leist's book *American Portraits*, a result of seven years of traveling across America, was published in 2001 by Prestel Press. Muntadas had solo exhibitions in France, Italy, Spain and Canada. His Public Art Seminar traveled to Las Vegas, where the class examined the city and its architecture as a uniquely American phenomenon and construction. Joe Gibbons's video "Confessions of a Sociopath" was shown at the Whitney Biennial, a prestigious museum exhibition that features work by leading and emerging American artists. The video was made with the support of a Guggenheim Fellowship and was listed among the 10 best videos of 1991 by *Artforum* and *Film Comment* magazines. Tarkowski collaborated in 2001 with architect Stanley Tigerman on a work for the Children's Advocacy Center in Chicago.

Graduate Thesis Exhibition

One of the program's most significant events of the year was its first graduate thesis exhibition, featuring the work of the program's six graduate students. The exhibition and opening reception were widely publicized and well attended, giving a long overdue public face to the program and the work of its students. The exhibition was sponsored in part by a grant from the MIT Council for the Arts.

Undergraduate Program

Associate professor Leslie Norford, the undergraduate officer, and Renée Caso, the administrator for academic programs, continued in their efforts to support and strengthen the undergraduate experience. The studio sequence implemented last year yielded excellent results. Undergraduates are represented in the renewed student architectural association. Two undergraduate students were selected to participate in the TU Delft/MIT exchange next year. The graduating seniors launched a new tradition, the Senior Dinner with faculty and administrators, in another example of an increasingly visible and productive program.

Aga Khan Program for Islamic Architecture

With this Report to the President, the Aga Khan Program for Islamic Architecture (AKPIA) begins reporting from within the Department of Architecture. It has completed its transition from an outreach-based program to an academic-based program. The AKPIA at MIT is recognized as a leading program in the study of architecture and urbanism in the Islamic world. To date, the program has had 111 graduates—10 PhDs and 101 SMArchS (Master of Science in Architectural Studies)—in addition to 18 PhD graduates of Harvard. Of those, 32 are teaching in leading universities in various parts of the Islamic world and in the West, and four are curators in major museums; others are either self-employed as designers or employed in architectural and construction firms.

To maintain its hard-earned status and to adapt to recent changes, AKPIA has been concentrating its teaching and research activities in the following directions: enhancing the understanding of Islamic architecture and urbanism in light of critical, theoretical, and developmental issues; supporting research at the front edge of the field in areas of history, theory and criticism of design, architecture, and urbanism; and providing an extensive base of information about architecture in the Islamic world and sharing it with scholars, teachers, and practitioners worldwide.

Over the years, AKPIA's size and functions fluctuated depending on funding and institutional commitment to the program. The program currently supports two professors, one librarian, one visual material archivist, and a small number of graduate students (six PhD and five SMArchS students). AKPIA is closely collaborating with ArchNet, sponsored by the Aga Khan Trust for Culture and located at MIT, in developing a web-based center of study and research on and about architecture in the Islamic and developing worlds.

Program Activities

In the academic year 2001–2002, the AKPIA hired a new assistant professor (Heghnar Watenpaugh); admitted one PhD candidate and three SMArchS candidates; graduated three SMArchS students; awarded four AKPIA travel grants; and supported two postdoctoral fellows (Bülent Tanju, Faculty of Architecture, Yildiz Technical University, Istanbul, and Kimiyo Yamashita, Research Fellow of the Japan Society for the Promotion of Science, Tokyo). The program offered an "Evening With" lecture series in addition to lecture opportunities for the postdoctoral fellows and the previous year's travel grant recipients.

Faculty Activities

Nasser Rabbat, Aga Khan associate professor and AKPIA director, published *Interpreting the Self: Autobiography in the Arabic Literary Tradition*, as well as articles in English and Arabic, and participated in numerous conferences. Heghnar Watenpaugh, assistant professor of the history of architecture and Aga Khan career development professor, contributed to "Museums and the Construction of National History in Syria and Lebanon," published in *The British and French Mandates in Comparative Perspective*, Peter Sluglett, Nadine Méouchy and Rashid Khalidi, editors, and "Sources and Methods for Studying Women and Islamic Cultures in the Disciplinary Field of Art and Architecture," in *The Encyclopedia of Women and Islamic Cultures*, Suad Joseph, general editor.

Department of Architecture Enrollments

Course IV counted a total of 285 students: 66 undergraduates, 99 MArch, 52 SMArchS/SM without specification, 4 SMBT, 6 SMVisS, 40 resident PhD, 18 non-resident PhD, and 1 special (non-degree) student. Course IV-B counted one undergraduate student.

Highlights of the Past Year

Symposium and Conference

In the fall term, Mark Jarzombek, with PhD candidate Juliana Maxim, organized a conference on "East European Art and Architecture," co-sponsored by the Graham Foundation, MIT's School of Architecture and Planning, and MIT's School of Humanities, Arts, and Social Sciences. In the spring term, Valeria Mazarakis organized a symposium on the work of Rafael Moneo, at which he was a respondent.

Lectures

The Architecture Lecture Series, organized by Stanford Anderson, included in the fall: Jane Thompson, Takashi Yamaguchi, Peter Eisenman, Brian Mackay-Lyons, Jesus Aparicio, Rick Joy, James Stewart Polshek, and Taina Rikala; and in the spring: Vito Acconci, Peter Wheelwright, Mario Coyula-Cowley, Juhani Pallasmaa, Nicholas Adams, and Rafael Moneo. Sir Nicholas Grimshaw presented the Fifteenth Arthur H. Schein Memorial Lecture. Heinz Isler gave the Fifth Felix Candela Lecture. The Pietro Belluschi Lecture was to have been given by Peter Zumthor, who had to indefinitely postpone his visit following the events of September 11. The Building Technology, Visual Arts, Aga Khan Program, and History,Theory, and Criticism programs also sponsored discipline-based lecture series which were open to the public. In addition, the department sponsored a lecture series and related activities on "September 11 and Aftermath," coordinated by Helene Lipstadt.

Publications

Thresholds, published twice a year as a journal edited and produced by students, is increasingly noted for developing

diverse architectural themes in each issue. It now has national recognition and its contents are systematically catalogued. *PinUp*, also wholly edited by students, served the department well as an internal newsletter. *FOUNDATIONS* is a monthly electronic newsletter sent to approximately 2,315 undergraduate and graduate alumni whose email addresses are registered with The Alumni Association. The newsletter contains brief items about the department as well as news of and opportunities for alumni.

Visitors and Lecturers

The department invited visitors and lecturers to contribute their special expertise to the curriculum. Visitors included Edith Ackermann, Francis Duffy, John Gero, Mary Lou Maher, Marlon Blackwell, Carol Burns, Hasan-Uddin Khan, Alan Joslin and Hubert Murray in Architectural Design; Edward Allen and Austin Parsons in Building Technology; Henry Millon, John Rajchman, James O'Gorman, Robert Haywood and Helene Lipstadt in History, Theory, and Criticism; Antonio Muntadas and Christine Tarkowski in Visual Arts. Appointed as lecturers were Daniel Greenwood in Architectural Design; Natalia Cardelino, David Whitney, Carl Rosenberg, and Barry Webb in Building Technology; Stuart Steck in History,Theory, and Criticism; and Reiner Leist and Joe Gibbons in Visual Arts.

Architecture Student Council

Students elected representatives to the Architecture Student Council (ASC) from each level and discipline. Student representatives served on a number of department committees including admissions and search committees, Department Council, and M.Arch. Curriculum committee, and attended studio faculty meetings as the agenda pertained. The ASC contributed agenda items to general departmental meetings.

Student Awards and Fellowships

Student Awards Designated by the Department or Institute

The William Everett Chamberlain Prize for graduating BSAD for achievement in design (Anna Gallagher). The Sydney B. Karofsky '37 Prize for the outstanding master of architecture student with one further year of study (Scott Cyphers). The Francis Ward Chandler Prize for achievement in architectural design (Junko Nakagawa, Daniel Steger). The Alpha Rho Chi Medal for leadership, service for the school and department, and promise of real professional merit (Ariel Fausto). The AIA Certificate of Merit for second-ranked master of architecture student (William Edward Pitts). The AIA Medal for the top-ranked master of architecture student (Nicole Michel). The SMArchS Prize (Cagla Hadimioglu, Ian Sheardwright, Paul Schlapobersky, Diana Ramirez-Jasson, Winnie Wong). The Imre Halasz Thesis Award (Nicole Michel). The AIA Foundation Scholarships (Joshua Barandon, Danny Chan). Faculty Design Award (Julie Kaufman, John Rothenberg, Nicole Vlado). Outstanding Undergraduate Prize (Sini Kamppari). Schlossman Research Fellow (Sadaf Ansari, Muhammad Ijlal Muzaffar). Ann Macy Beha Travel Award (Christopher Johns, Aaron Malnarick, Mahjabeen Quadri, Xin Tian). Louis C. Rosenberg Travel Award (Chiu-Fai Eddie Can, Kenneth Namkung). Avalon Travel Grants (Michele Lamprakos and Kirsten Weiss). Marvin E. Goody Prize (Rocelyn Dee). Aga Khan Program Summer Travel Grant (Leonard DiazBorioli, Sarah Rogers, William Doss Suter, Lieza Vincent). Robert Bradford Newman Medal for Merit in Architectural Acoustics (Meredith Elbaum). Marjorie Pierce/Dean William Emerson Fellowship (Sabrina Schmidt-Wetekam). Hyzen Travel Fellowship (Janna Israel). Rosalia Ennis '76 Research Award (Britta Butler). Rosemary D. Grimshaw Award (David McLean). Council for the Arts Grants (Jacquelyn Martino, Zeynep Celik).

External Awards

Getty Library Research Grant, MIT/CCA Travel Grant (Thomas Beischer). College Art Association Travel Grant and American Institute of Iranian Studies Fellowship (Talin Der-Grigorian). Andrew W. Mellon Foundation Pre-Dissertation Fellowship (Kirsten Weiss). Martin Family Society for Sustainability Membership (Brooke Wortham). 2002 Kress Fellow 2002 de Montequin Jr. Fellow (Glaire Anderson). Preservation Society of Newport County Scholarship Award (Leonardo Diaz-Borioli). The Mary Davis Fellowship, Center for Advanced Study in Visual Arts (Alona Nitzan-Shiftan). The Sandberg Prize, The Israel Museum (Alona Nitzan-Shiftan). 2001 American Institute of Architects Award for Advanced Study and Research (Singh Intrachooto). Schnitzer Prize in the Visual Arts (Jacquelyn Martino). PLEA Conference Best Paper Award (Joao Rocha).

Stanford Anderson
Department Head
Professor of History and Architecture

More information about the Department of Architecture can be found on the web at http://architecture.mit.edu/.

Program in Media Arts and Sciences

In its third year, the alternative freshman year program of the Program in Media Arts and Sciences (MAS) enrolled 22. These students took special Media Lab recitation sections of two core freshman subjects, pursued Media Lab UROP research projects, and participated in two new MAS undergraduate subjects on design and research. We view this program as a first step toward establishing a full-fledged undergraduate program in the future.

Education

For 2001–2002, the MAS graduate program received 356 applications, a 10.5 percent increase over last year. From these, 56 new students (including 12 women) were offered admission: 44 for the master's program, and 12 for the doctoral program. This brought the total MAS enrollment to 151, which included 44 women, four underrepresented minorities, and 56 foreign students. Of the total, 84 were master's candidates, and 57 were doctoral candidates. Fifty-two advanced degrees were awarded during the year (40 SM and 12 PhD). The program offered 35 graduate subjects.

In addition, MAS faculty and research staff collectively advised and supported 32 graduate students from other MIT departments and programs. These included Electrical Engineering and Computer Science, Chemistry, Physics, Mechanical Engineering, Aeronautics and Astronautics, Materials Science and Engineering, Health Sciences and Technology Program, Technology and Policy Program and the Sloan School of Management.

The largest undergraduate presence at the Media Laboratory continued to be our UROP students, more than 250 of whom participated in research projects at the Media Laboratory. Many of these undergraduates pursued their undergraduate theses under MAS faculty supervision. In addition, the Program in Media Arts and Sciences offered eight undergraduate subjects, and four MAS faculty members and staff conducted freshman seminars or served as freshman advisors.

Faculty and Staff

New Appointments

Cynthia Breazeal was appointed assistant professor of media arts and sciences. Dr. Breazeal received her MS and ScD degrees from MIT in electrical engineering and computer sciences in 1993 and 2000, respectively. While a graduate student at MIT's AI lab she served as a consultant for Walt Disney Imagineering, Inc., where she worked on interactive robotic characters and was also a visiting scientist at the Santa Fe Institute. At the Media Laboratory she will head the new Robotic Presence research group.

Chris Csikszentmihályi was appointed assistant professor of media arts and sciences. He received his BFA from the School of the Art Institute of Chicago in 1994, and an MFA from the University of California, San Diego in 1998. He went on to become an assistant professor of electronic art at Rensselaer Polytechnic Institute. At the Media Laboratory he will head the new Computing Culture group.

Honors and Awards

Faculty Awards

John Maeda was honored with the "special award" of the Mainichi Design Prize for 2001. The award is Japan's oldest and most prestigious design award, presented each year to "the designer, group, or organization judged to have the greatest impact on design."

John Maeda was also the recipient of the 2001 National Design Award from the Smithsonian's Cooper-Hewitt National Design Museum. The award recognizes a body of exceptional and exemplary work in graphic or multimedia design.

Scott Manalis was selected by Technology Review as one of the 100 "brilliant young innovators, all under 35, who will have a deep impact on how we live, work, and think in the century to come."

Joseph Jacobson was one of eight scientists to receive *Discover* magazine's 2001 Award for Technological Innovation. These awards recognize groundbreaking work of far-reaching impact with relevance to our daily lives.

New Books

Vanessa Stevens-Collela, Eric Klopfer, Mitchel Resnick, *Adventures in Modeling*, published by Teachers College Press.

Cynthia Breazeal, *Designing Sociable Robots*, published by MIT Press.

Stephen Benton
Director
Allen Professor of Media Arts and Sciences

More information about the Program in Media Arts and Sciences can be found on the web at http://www.media.mit.edu/mas/.

Department of Urban Studies and Planning

A major event this year was the meeting of the Visiting Committee to the Department of Urban Studies and Planning (DUSP), held on December 5 and 6, 2001. The report of the committee affirmed that DUSP is in "overall excellent health." The committee gave high marks to faculty leadership, an intellectually strong student body, a broad and diverse curriculum, and acknowledged the significant institutional support from MIT. The visiting committee praised the new core curriculum that we are currently implementing in the Master in City Planning (MCP) Program. The new core focuses more on experience in practice as a medium for action and research in planning. It ends 20 years of separation between international and domestic teaching, recognizes globalization and integrates digital technology and media into all skills classes.

Another top priority for 2001–2002 was to intensify our student recruitment effort, part of our efforts to remain competitive with the other top planning programs, especially Berkeley and Harvard. A new video highlights the wide range of field-based opportunities available for students to work in collaboration with faculty on real-world planning problems. This unique tie between theoretical academic studies and field-based action research is one of the continuing allures of the program. Applications to our master's program were up more than 50 percent this past year, and more than 80 percent of those offered admission accepted our offer. In view of this unprecedented high yield, which will bring us a larger than expected entering class, we will endeavor to admit fewer applicants next year, thereby enhancing our selectivity. Yield on admission to our small doctoral program was also high, surely aided considerably by the offer of Presidential Fellowships, which remain highly valued by the department. In light of the ongoing urgency to provide financial aid to our graduate students, the department agreed to turn in a faculty slot (resulting from the retirement of Professor Bernard Frieden in July 2002) to be used for this purpose.

In additional student recruitment matters, the department is also actively seeking ways to involve our alumni/ae in the life of the department. We are in the process of launching a series of regional receptions for alumni and prospective students, to be held each fall in four cities.

In June 2002, we also presented our first Excellence in Public Service awards, recognizing three DUSP alumni/ae for their outstanding contributions by providing them with some loan forgiveness. We do not yet have sufficient endowment to institutionalize this program, however.

Space continues to have a big impact on the life of the department. While renovations are completed in Buildings 9 and 3, there is still a shortage of classroom and office space. We are anxiously awaiting the availability of space in Building 33 or Building 9. Fortunately, the department's renovated space is used very efficiently and remains a great asset to the program.

One further area of concern, also raised pointedly by the visiting committee, is the future of the School's Center for Real Estate (CRE). With the departure of Professor Tim Riddiough for a business school position at the University of Wisconsin and Larry Bacow's appointment as president of Tufts, the department is actively engaged in recruiting new leadership for CRE.

Faculty Achievements

Professor Anne Whiston Spirn received the ninth annual International Cosmos Prize for research that has contributed to the "harmonious co-existence of nature and mankind." Professor Spirn, who is the youngest person, first woman and the first designer/planner to win the award, received 40 million yen ($324,400), a gold medal and a commendation in Tokyo in October 2001.

The Lewis Mumford Prize of the Society of American City and Regional Planning History went to Professor Robert Fogelson. Professor Keith Hampton won a Canadian Policy Research Award, as well as a Graduate Student Council Teaching Award. Professor Diane Davis was chosen as a Carnegie Scholar. The 2001 Best Book Award from the American Political Science Association went to lecturer William Shutkin. Professor Ceasar McDowell was selected for a 2001 YMCA Black Achiever Award.

Professor Dara O'Rourke was selected to hold the Mitsui Career Development Professorship. Professor Lawrence Vale was promoted to full professor. The department hosted two Martin Luther King visiting professors—Raul Lejano and J. Philip Thompson.

Contributions to MIT-wide Efforts

The department launched plans for a series of annual joint studios with faculty and students from the University of Cambridge, as part of the Cambridge-MIT partnership (CMI). The first of these studios in the fall of 2001 proposed design strategies for accommodating growth pressures in Cambridge, England. A follow-up studio will be held in the fall of 2003, focusing on university/high-tech industry development in the Cambridge, MA, vicinity and Route 495 corridor. A second CMI-sponsored research project, examining the planning and economic effectiveness of place-based high-tech research clusters, was launched in 2001, and another CMI-related proposal is being developed in conjunction with British Telecom. This studio sequence and research agenda is part of a larger and longer collaboration, still under consideration by CMI, that creates a Joint Center for Urban and Regional Innovation.

DUSP's environmental policy faculty have become increasingly involved in campus-wide environmental

policy projects of various kinds. MIT's Alliance for Global Sustainability and its Martin Fellowship Program are supporting graduate students and faculty exploring alternatives to traditional forms of regulation. The Mexico City Project, directed by Professor Mario Molina, is supporting several DUSP faculty and students as part of an effort to reduce air pollution in Mexico City. Environmental policy graduate students were linked to the MIT Global Change Program, examining strategies for carbon sequestration and the introduction of electric vehicles in developing countries.

DUSP continues active involvement in a long-term plan for collaborative research with the Technical University of Delft, with proposals expected in 2002. Other work in collaboration with Dutch officials is already underway.

Research and Teaching on Urban Planning

The intellectual life of the department is organized largely around the activities of the five program groups, which reflect major areas of current planning practice and scholarship: City Design and Development; Environmental Policy; Housing, Community and Economic Development; International Development and Regional Planning; and Planning Support Systems (Information Technology).

During the summer of 2001, faculty and students from the City Design and Development (CDD) group worked with the World Bank Institute to offer a course on urban development in Bhutan, focusing on the future of the capital city, Thimpu. Following the workshop, which involved virtually every urban professional in Bhutan, three students were invited by the Royal Government of Bhutan to continue their research that resulted in three outstanding theses on conservation of traditional culture, landscape and buildings.

CDD faculty and students organized a special colloquium and seminar entitled "The Resilient City: Trauma, Recovery, and Remembrance" that brought together scholars and urbanists to consider the meaning of the September 11 tragedy by examining historical precedents for rebuilding in cities world-wide. The colloquium presentations were transmitted as digital video on the MIT World web site, and enabled the series to engage a worldwide audience. The colloquium was also written up in the *Boston Globe*. In May 2002, Professor Lawrence Vale, joined by a DUSP graduate student, spoke about the colloquium to a well-attended gathering of major MIT donors in New York. Results of the colloquium, organized by Professor Vale and Dr. Thomas Campanella, will be published in a book.

Research activity of the CDD group continued with major results in several areas. Our collaboration with the Generaletat de Catalunya resulted in the publication of a monograph entitled *Designing the Llobregat: The Cultural Landscape and Regional Development*, that has been widely distributed. In collaboration with the Universitat Politecnica de Catalunya (UPC), a new research initiative now being considered by the government will establish an MIT/UPC International Laboratory for the Study of the Cultural Landscape in Barcelona. In Seoul, Korea, Professor Dennis Frenchman and Dr. Campanella, along with Research Scientist Michael Joroff and students, led an international team to design the Seoul Digital Media city, the first large-scale project to incorporate digital media into design of the public environment. The work of the team was featured in *Fortune* and *International Herald Tribune*. Finally, research continues with the Media Lab on tools for Tangible Urban Simulation and new technology invented at MIT is now being used in studios and workshops.

The Environmental Policy Group (EPG) continues its work on a series of comparative case studies analyzing public policies that encourage sustainable development, particularly the adoption of "greener" technologies in various parts of the world. The Environmental Technology and Public Policy Program (within EPG), with support from the Dutch government, published a path-breaking study of Public Entrepreneurship Networks—new partnerships among public agencies, private companies and civil society that have been able to encourage environmental innovation. The group also recently launched an environmental justice initiative that includes teaching, research, and capacity-building activities.

Industrial ecology is a new area of research at DUSP. EPG faculty are exploring new policy strategies to promote industrial innovation and new mechanisms for bringing the concerns and energies of consumers, communities and companies to bear on reducing the adverse environmental and social impacts of industrial systems.

EPG hosted a number of distinguished visitors during the year, including Professor Raul Lejano, who was the holder of a Martin Luther King Visiting Assistant Professorship for the second year; Professor Dr. Leo Jansen, former member of Parliament and founder and director of the Sustainable Technology Development Program, the Netherlands, who gave a talk at an EPG lunch entitled Future Present: Planning, Community and Sustainable Development; and Professor Dr. Wim Hafkamp, of the Erasmus Center for Environmental Studies, Erasmus University, Rotterdam, The Netherlands.

Faculty in EPG organized and hosted a number of conferences and workshops, including the continuing Civic Environmentalism Roundtable. The civic environmentalism series, convened in partnership with faculty from Harvard's Kennedy School, produced a report in the spring entitled "Memo to the Governor: The Commonwealth That Could Be," providing policy recommendations to the

2002 Massachusetts gubernatorial candidates. The project is sponsored by the American Society for Public Administration. EPG also helped convene the Second Annual Regional Sustainable Development Forum at MIT in September 2001, with over 250 in attendance and close to 50 presenters.

For the ninth year in a row, EPG faculty chaired the International Programme on the Management of Sustainability, held each year in the Netherlands to assist 40 governmental and non-governmental staff from the developing world in their efforts to implement Agenda 21.

The Housing, Community and Economic Development (HCED) group spent academic year 2001–2002 involved in many of the activities and concerns that have motivated it for the last several years:

- Utilization of the Wednesday luncheons as a forum for "reflective practitioners" in the greater-Boston area working in community development. We were fortunate this year to have strong speakers who are actively engaged in planning issues in Boston and who saw the luncheons as a forum both to frame "grounded" problems and to seek explicit advice from our students and faculty.
- Deeper involvement in planning activities in Lawrence, MA, where a number of HCED graduates, a rank that expands annually, are working for a creative community development corporation that is having a major impact on its low-income neighborhood
- Expansion of work in the Boston Main Streets Program where Senior Lecturer Karl Seidman has forged a strong working relationship with program managers of several of the neighborhoods
- Engagement during the fall semester with Ernesto Cortes, south west regional director of the Industrial Areas Foundation, an inspirational visitor from the world of organizing who challenges us on our assumptions about community development.
- Expansion of field-based practica that cut across the department's program group boundaries.

In addition to these five areas of continuity the HCED group spent collective time considering how to more effectively connect with the Center for Reflective Community Practice (see below) and other program groups in the department around the issue that we came to call "the new minorities in the cities." Given our experiences in Lawrence with the Hispanic community and the Boston Main Streets program's newly arrived ethnic groups, we are striving to both conceptualize and engage in practice with the "complexity of community" that emerges with the arrival of new immigrant groups. No longer is the formulation simply one of black and white or even Hispanic and black and white. Other ethnic groups from Latin America, Southeast Asia and the Caribbean make a more complex and challenging mosaic of interests than our traditional "neighborhood model" accounts for. As the department moves forward with hiring decisions to provide a greater minority presence on the faculty, we are looking to engage any new faculty arrivals in this "new minorities" agenda. Based as it is in practice in the neighborhoods, the department and HCED in particular are in a position to contribute significantly to this new agenda.

The faculty in the International Development and Regional Planning (IDRP) group are involved in nine major multi-year research and teaching activities, each involving two to seven graduate students and/or SPURS (Special Program in Urban and Regional Studies) Fellows.

Professor Balakrishnan Rajagopal is now director of the MIT Program on Human Rights and Justice, which is a collaborative effort between DUSP and the Center for International Studies. The program organized many events this year, including a speaker series, conferences, and is supporting several student internships. Professor Rajagopal has a book forthcoming early next year from Cambridge University Press entitled *International Law from Below: Development, Social Movements, and Third World Resistance*, and he has recently published several articles, including op-ed pieces in the *Washington Post* and the *Hindu*. He also has a multi-year research project on globalization and local democracy and is part of a faculty research team on another project on globalization, development and standards.

A second major highlight was the publication by Professor Alice Amsden of a seminal article in *Research Policy*, the prestigious non-technical journal on research and development. She developed a new methodology to determine how close a lab's research is to the world frontier without having to delve into the subject matter of the research. This gives policy makers a better chance to customize their science and technology policy efforts.

A third important initiative is being undertaken by Professor Diane Davis, who is investigating public insecurity in cities of the developing world. She and several students are focusing on Mexico City, Johannesburg, and Moscow. They are centering their research on the relations between globalization and spatial changes in cities of the developing world, which manifests itself in more physical polarization in cities, contributing to crime, violence, and public insecurity. For her innovative Scholarship in Education, International Development, Strengthening US Democracy, and International Peace and Security work, Davis has been named one of sixteen leading researchers by the Carnegie Scholars program.

A fourth significant activity is the conclusion of a World Bank-funded research effort by Professor Jennifer Davis on public water and sanitation agencies in four South

Asia research sites. These agencies have been able to make substantial improvements in service delivery, accountability to customers, reduced corruption, and increased transparency. Using intensive data collection through interviews and surveys, the researchers have been working to understand the conditions under which various reform strategies have succeeded in boosting public-sector performance within South Asia's highly constrained institutional environment. A series of publications from the research are now in preparation.

A fifth important event was the publication by Professor Judith Tendler of a major critique of social-policy thinking and practice in the developing world, and suggestions about how to solve these problems as part of a comprehensive United Nations' effort to re-think social policy. The publication was one of a number from a multi-year joint research project involving DUSP graduate students and MIT faculty in Northeast Brazil, and funded by Brazilian state governments and the Bank of the Northeast—a body of research that has given rise to 30 publications and theses. The most recent project on re-thinking regional policy, funded by the Bank of the Northeast, has looked into the role of policy, public institutions, and markets to determine which sectors, states, and/or firms fared better, which kinds of development had greater spill-over effects and why, and the conditions under which growth was income-distributing rather than income-concentrating and worker skills and conditions improved rather than degenerated.

Work by the sixth group is in the People's Republic of China. Professor Karen R. Polenske is supervising a multidisciplinary team of chemical engineers, physicists, and planners from China, Japan, Switzerland, and the United States. They are completing research on energy conservation and pollution-reduction projects in the coke-making sector in Shanxi Province and are beginning to study energy-efficiency issues in iron and steel plants in Liaoning Province. She is also one of three lead investigators of another newly funded Alliance for Global Sustainability (AGS) project on the yellow dust problem in China. The team is investigating the sequence of events that led to the atmospheric transport of the dust from the north and west of China and the economic and health effects this has on society in China, Japan, and Korea. The researchers are determining the types of critical interventions needed to reduce the problem and the localities where these interventions will be most effective.

Professor Ralph Gakenheimer is working with a seventh group of faculty and students to study the increase of mobility and motorization in developing countries. They are currently focusing on the future of the personal use of automobiles in China and on an integrated assessment of environmental quality in Mexico City. They are also collaborating with others at MIT to organize a graduate program in transportation and logistics systems for the new Malaysia University of Science and Technology.

An eighth group, led by visiting lecturer Anna Hardman, is continuing to work on the impacts of rent decontrol on housing markets in Egypt.

Finally, Professor Bish Sanyal is leading an effort to establish a Learning and Education Alliance and Resource Network (LEARN) as a way for universities to influence urban poverty-alleviation policies in developing countries. The collaboration would eventually enhance the legitimacy of the university in facilitating policy discussions among governments, market institutions, and civil society. Using MIT's OpenCourseware Initiative, LEARN can play a leadership role in utilizing information and communication technology for educational purposes.

During June, many of the IDRP faculty lectured to the 50 participants in two development workshops: Municipal Water and Sanitation Pricing and Tariff Design in Developing Countries; and Upgrading Urban Slums in Developing Countries, offered in collaboration with the Cities Alliance.

Many of the research efforts by the IDRP group focus on comparative studies between industrialized and developing countries. Overall, the faculty and students are working or planning to work on all continents.

Research and teaching in the Planning Support Systems (PSS) group has continued to explore the growing impacts of information technology on urban planning, metropolitan governance, and our sense of community. Advances in information technologies have enabled the location and spatial interaction of people, buildings, and events to be tracked, modeled, visualized, and manipulated as never before. The result has been a rapid growth of new opportunities—and risks—ranging from e-government, environmental monitoring, and urban modeling to increased concerns about privacy, security, "big brother," redlining, and a digital divide.

Midway through the year, Professor Lorlene Hoyt joined our faculty after completing her University of Pennsylvania dissertation on the public safety and community development impacts of business improvement districts. Her understanding of spatial analysis tools and municipal agency infrastructure quickly found an audience in the Spring Geographic Information Systems (GIS) Workshop, where two class projects focused on Philadelphia crime analyses and community development in Lawrence, MA. Meanwhile, Professor Keith Hampton's work on community networking and electronic neighborhoods received National Science Foundation funding for a multi-year study. The new grant expands his e-neighborhoods experiment that began in July 2001, and will be a three-year study of how new communication technologies can be used to build local social capital. A spring series of public forums and online web pages culminated another project, "Beyond the Big Dig," spearheaded by research scientist Tom Piper. Through collaboration with the *Boston Globe* and Channel

5, the project experimented with technology-mediated public participation processes for stimulating public dialogue about the future of the 30 acres of public space above the newly sunken central artery. Professor Joseph Ferreira continued work with the Open GIS Consortium and the Federal Geographic Data Committee on the interoperable GIS. These next-generation GIS tools and standards provide the interoperability and modularity that metropolitan agencies and non-governmental organizations (NGOs) need to coordinate programs and share spatially referenced data effectively. We have also worked with MIT Information Systems and the MIT Libraries' newly hired GIS and statistics specialist to enhance the capabilities and interoperability of MIT's spatial data infrastructure.

PSS researchers have also continued collaborative work with other MIT departments and centers. For example, we have worked with the Department of Civil and Environmental Engineering and the Center for Transportation Studies on IT-related transportation planning work with the Chicago Transit Authority as well as with Puerto Rico's new "Tren Urbano." We have also completed a NASA-funded project on urban "respiration" that teamed up with atmospheric modelers in MIT's Chemical Engineering Department and several scientists at other universities and research firms to study how land-use planning can affect metropolitan air pollution patterns. Other active research areas include welfare-to-work accessibility, land use and transportation interactions, urban design assistance, environmental justice screening, and political redistricting. Each of these areas has involved class projects and thesis work with "real world" partners and impacts involving several federal, state, regional and local agencies and NGOs. All the work has been challenging this past year since the group and its computer facilities moved twice to accommodate a complete remodeling of our workspace on the fifth floor of Building 9. The work has been especially rewarding for several PSS students who won the Urban and Regional Information Systems Association (URISA) prize for the best student paper at their annual conference (PhD candidate Liou Cao), the department's prize for the best undergraduate thesis (Jonathan Reed), and the best PhD dissertation (Mizuki Kawabata).

Graduate Degree Program Enrollment and Activities

Our graduate programs enrolled 196 students this year. Of the total, 57 percent were women, 13 percent were underrepresented minorities, and 33 percent were international students. The department granted 59 MCP, 1 SM, and 8 PhD degrees.

Faculty continued to offer a wide array of for-credit offerings during the Professional Development Institute held in the Independent Activities Period. In addition to Introduction to Computers in Public Management II—required of all first-year master's students—four additional for-credit courses were offered this year: Management Fundamentals for Leaders in Non-Profit Organizations; Turning Disasters into Development Opportunities; Springfield Design Studio: Organizing with Information; Market-Based Inner-City Economic Growth; and Planning Use of Online Socioeconomic Data. These classes, combined with non-credit offerings, attracted both undergraduate and graduate students from across the Institute, alumni/ae and local professionals.

The Master's in City Planning (MCP) Committee devoted much of its time this year to developing the new core curriculum in the Master's in City Planning Program that was approved last year. This is the flagship academic program of our department. The major thrust of the new curriculum is to reassert the common values and practices that bind together different areas in the profession. Within recent years, these areas have become increasingly independent, threatening our focus on the core mission of city planning and its increasingly international role.

Elements of the new curriculum that will be implemented this fall include:

- New "gateway" subjects on cross-cutting issues and recurring themes of planning, entitled Planning Action and Planning Economics
- Introductory subjects to specialization areas in planning
- A new subject entitled Planning Communications and Media, the first in a sequence of skill subjects that will integrate computing skills into content (rather than offering separate computer classes). Other new or revised subjects will include Quantitative Reasoning and Computing, and Research Methods and Computing

Finally, a new requirement that all MCP graduates participate in a practicum workshop involving communities and clients in the field will be implemented next year.

The PhD Committee addressed a number of issues during the year, including admissions, methodological course requirements, shifting the timing and content of the first-year methods course during which time students write their first-year paper, how the students are reviewed, and the distinction between the first and second fields in the general exam. Further work on these issues will continue next year. In particular, the committee plans to expand its efforts to recruit the best students.

Undergraduate Program Activities

During 2001–2002, the Undergraduate Committee worked with DUSP undergraduate majors, minors and students in the DUSP/Political Science Public Policy Minor to improve course offerings and to give DUSP courses

greater visibility among MIT undergraduates. These efforts are beginning to bear fruit. During the year, eight upperclassmen transferred into the department as urban studies majors. In the late spring, after DUSP's open house, an additional four freshman declared an urban studies major, indicating a modest increase of undergraduate commitment to the department.

As in earlier years, the department offered an annual study trip to a foreign city. During IAP 2002, Professor Diane Davis led a study trip to Mexico City in which six majors participated. The trip was preceded by a fall seminar introducing students to issues of governance, planning and economic development in a city experiencing explosive population growth.

In cooperation with the Department of Political Science, we continued to refine the jointly run HASS Public Policy Minor. Changes include shifting one of the required courses to a capstone course to allow students to draw on policy knowledge they have acquired in electives. This year, the introductory course in the minor, 11.002/17.30 Public Policy and Government Action, had an enrollment of 28 students. As the course minor's reputation spreads through word of mouth and a redesigned web site (http://web.mit.edu/polisci/publicpolicy/), we expect enrollment in the minor to grow significantly.

Through the Teacher Education Program (TEP), directed by Dr. Eric Klopfer, MIT undergraduates can complete certification in secondary math and science teaching. While the number of students currently certified by the TEP is relatively small, it does certify teachers in high-need areas such as physics and mathematics.

In the past, MIT students who wanted to obtain teacher certification were required to attend classes at Wellesley College. This year, TEP piloted a new program to certify teachers entirely at MIT. The program was a success and has attracted great student interest for next year. Through this program TEP should be able to greatly increase the number of MIT students receiving teacher certification.

Over the last year, the TEP has also strengthened its relationship with the Cambridge Public Schools through new projects. At the same time, it has furthered relationships with the Boston Public Schools, especially Boston High School (which will become a pilot school in the fall) and the new Tech Boston Academy. Dr. Klopfer has also hosted summer institutes on educational technology for teachers from around the Boston area and around the world in conjunction with TEP. We are delighted that he has become the first holder of the newly created Joseph B. (1954) and Rita P. Scheller Career Development Professorship in Teacher Education.

For more information on TEP see http://education.mit.edu/.

Student Awards

Our graduate and undergraduate students received many awards from national and international organizations, the Institute, and the department.

Departmental Awards

The American Institute of Certified Planners, Outstanding Student Award winner is Ronald Mallis of Brooklyn, NY. Jean Riesman of Providence, RI, won the award for Outstanding Contribution to the Intellectual Life of the Department. The Departmental Service Award went to Rosemary Dudley of Albuquerque, NM, and Marisa Gaither of Los Angeles, CA. Katherine Fichter of Boston, MA, won the Flora Crockett Stephenson Writing Prize.

Jason Corburn of New York, NY, and Mizuki Kawabata of Tokyo, Japan, received the Outstanding PhD Dissertation Award. The Outstanding MCP Thesis Award went to Alberto Criscuolo of Napoli, Italy, and a team consisting of Alexis Bennett of Venice, CA, Rosemary Dudley of Albuquerque, NM, and Rachel Loeb of Kansas City, KS. The Outstanding Undergraduate Thesis/Project Award was presented to Jonathan Reed of Bristol, RI.

Peilei Fan of Shanghai, China; Alexis Gensberg of Carmel, CA; and Emi Mizuno of Kishiwada, Japan won Lloyd and Nadine Rodwin International Travel Fellowships. Beatrice Chen of Taipei, Taiwan, Julie Kirschbaum of Edina, MN, and Desiree Sideroff of Los Angeles, CA, received Rubinstein Foundation Resilient City Fellowships.

Urban Design Certificates went to Hope Fang of Berkeley, CA, Eric Feldman of New Haven, CT, Rachel Loeb of Kansas City, KS, Richard Milk of Miami Beach, FL, Laurie Pessah of Los Angeles, CA, Masayoshi Sasazawa of Tokyo, Japan, Carol Tucker of Westford, MA, and Chong Yean Teo of Penang, Malaysia.

MIT Awards

Malo Hutson of Roswell, NM, Celina Su of East Brunswick, NJ, and Yan Zhang of Beijing, China, received Harold Horowitz (1951) Student Research Fund Awards. Hutson also won an Industrial Performance Center Summer Research Grant. Raquel Gomes of Fortaleza, Brazil, and Raja Shankar of Pune, India, received Industrial Performance Center Fellowships. Program on Human Rights and Justice, Summer Internship Awards went to Jovonne Bickerstaff of Akron, OH, Jeff Duritz of Philadelphia, PA, Christina Erickson of Sacramento, CA, Tina Pihl of Toronto, Canada, and Shinu Singh of Los Altos, CA. Bickerstaff also received the Ilona Karmel Writing Prizes Competition 2001–2002, Robert A. Boit Prizes, First Prize in Short Story and Honorable Mention in Essay, and the William L. Steward Jr. Award.

Smita Srinivas of Bangalore, India, won an Industrial Performance Center Pre-Dissertation Grant. Sunil Tankha

of Calcutta, India, received a Center for International Studies Energy Technology and International Affairs Grant. The Marvin E. Goody Award went to Alexis Bennett of Venice, CA. Ben Hudson of Vicksburg, MS, received the Hugh Hampton Young Fellowship (2000, 2002). Kathy Diaz of Bronx, NY, won a Mellon Grant on NGOs and Forced Migration. Tamam Mango of Amman, Jordan, won the Boit Manuscript Second Prize. Karen Thundiyil of Rockford, IL, received an Anthony Sun MISTI Internship Award. Seniors inducted into the Phi Beta Kappa Society included Jeffrey Roberts of Troy, OH, and Jaisel Vadgama of Calgary, Canada.

Other Awards

Brett Ballard of Marietta, OH, won a Heifer Project/ International/Cambodia Grant. The Phellan Fellowship from the International Labour Organization went to Monica Pinhanez of Sao Paulo, Brazil. Switzer Environmental Fellowships were presented to Cybele Chang of Glencoe, IL, and Carol Tucker of Westford, MA. Chang also won an American Association of University Women Education Grant.

Kris Kolodziej of Edison, NJ, won a National Council of State Garden Clubs Award (2001), Geospatial Information Technology Association Award (2001) and a GIScience 2000 Scholarship. Department of Housing and Urban Development Fellows were Roxanne Figueroa of Berkeley, CA, Marisa Gaither of Los Angeles, CA, Antonio Gonzalez of San Francisco, CA, Moshe McKie-Krisberg of Berkeley, CA, Olga Merchan of Cali, Columbia, and Jesse Williamson of Berkeley, CA. Diana Aubourg of Cambridge, MA, and Jimar Wilson of Los Angeles, CA, were Woodrow Wilson/Public Policy and International Affairs Fellows. Aubourg was also a Harry S. Truman Scholar. Aubourg and George Proakis of Boston, MA, won Rappaport Public Policy Fellowships. Larisa Ortiz of Ossining, NY, received a Rappaport Internship.

The Massachusetts Chapter of the American Planning Association gave the Student Project of the Year award to the team of Chang; Hilary Chapman of Lovettsville, VA; Jennifer James (MCP '01), Esther Lee of Bellevue, WA; Rachel Loeb of Kansas City, KS; Ronald Mallis of Brooklyn, NY; George Proakis of Boston, MA; Jeffrey Roberts of Troy, OH; and Frances Switkes of Santa Cruz, CA. Apiwat Ratanawaraha of Bangkok, Thailand won a Yenching Fellowship. Chapman won a Capital City Fellowship. An American Planning Association Smart Growth Congressional Fellowship went to Michael Donovan of Tacoma, WA. Celina Su of East Brunswick, NJ won a Javits Fellowship.

Liou Cao of Nanchang, China won Best Student Paper at the 2001 Urban and Regional Information Systems Association Annual Conference. The Charles Abrams Award went to Kathy Diaz of Bronx, NY. Laurie Goldman of Mineral Wells, TX received a HUD Early Doctoral Student Dissertation Grant. Ana Nogueira of Sao Paulo, Brazil won an Inter-American Development Bank Japan Scholarship. German Lleras of Bogota, Columbia and Sushila Maharjan of Kathmandu, Nepal received Fulbright Scholarships. Katherine Fichter of Boston, MA; Chitra Kumar of Granger, IN; Tina Rosan of New York, NY; and Emily Rubenstein of New York, NY were selected for Presidential Management Internships.

Outreach to Alumni/ae

Local alumni/ae continued to play an active role in sponsoring internships for students, providing career advice at the alumni/ae career forums organized by each of the department's program groups and participating as guest lecturers in numerous classes. At the same time, the department stepped up efforts to enhance connections with alumni/ae across the country and abroad. In July 2001, DUSP hosted a well-attended alumni/ae reception in Shanghai in association with the Shanghai MIT Club on the occasion of the World Planning Schools Conference. In the fall, more than a dozen doctoral alumni/ae from across the country joined Chancellor Phil Clay, Department Chair Bish Sanyal, the DUSP PhD Committee, current PhD students and other DUSP faculty at a day-long session focused on Doctoral Planning Education Today. This session was part of the department's efforts to involve alumni/ae to a greater and more meaningful extent in discussions about curriculum.

In support of our Alumni/ae Relations Initiative's goal of establishing a series of regional groups across the US, Chancellor Phil Clay and Departmental Chair Bish Sanyal hosted a leadership breakfast in Washington, DC, in the fall and a leadership dinner in Chicago in the spring. The department also again hosted successful receptions for DUSP alumni/ae and prospective students in Los Angeles and New York City in the fall. Departmental receptions held at the annual conferences of the American Planning Association and Association of Collegiate Schools of Planning provided venues to catch up with alumni/ae from across the country. Local alumni/ae joined faculty and students at a special lecture by Manuel Castells and associated reception.

The department proudly presented the first annual Excellence in Public Service Awards to Kristin Harol (MCP '99) of Lawrence, MA, Anthony Ng (MCP '98) of Brooklyn, NY, and Colin Riley (MCP '00) of Boston, MA.

International Connection

The Special Program for Urban and Regional Studies (SPURS) hosted sixteen fellows from Brazil, China, Ecuador, Korea, Latvia, Russia, and Venezuela. Of this year's fellows, five from China were sponsored by UNIDO and two from Ecuador and Venezuela completed the MS SPURS degree. The work of the fellows embraced several fields, including economic history and thoughts, economic

development, infrastructure planning, low-income housing, NGO management, transportation infrastructure, and urban design and development.

The events of September 11 were felt in a special and troubling way in a program so specifically intended to deepen understanding across all national and cultural boundaries. This theme ran through the Spring Monday SPURS seminar series, which brought speakers from throughout the world to speak on the "Culture of Planning" in their home country.

In October 2001, we lodged a successful application with the Humphrey Fellowship Program in Washington to renew MIT as a site to host the Humphrey Fellows in urban and regional development for the period 2002–2008. As a result, this fall we will be welcoming five Humphrey Fellows alongside an expected group of about ten SPURS Fellows for a total group of about fifteen fellows.

The January SPURS Seminar brought forward vigorous and interesting presentations by this year's fellows under the title "Text and Context: A Toolbox for International Development." The IAP seminar also gave us the pleasure of welcoming Aprodicio (Prod) Laquian, who carried the responsibilities of director of the program during the spring semester while John de Monchaux took a sabbatical leave.

Community Partnerships

The core activities of the Center for Reflective Community Practice (CRCP) are organized around long-term community partnerships, through both inquiry-based practice and applied research. This year's activities included:

- Community reflection groups: Springfield and Lower Roxbury—These groups were made up of CRCP community fellows who agreed to be part of community-based groups meeting regularly to learn reflective practice techniques and apply them to their work in the community.
- Reflective practice seminars—CRCP initiated its first reflective practice seminar in February 2002 with a reflection seminar for community organizers to examine the theoretical framework and assumptions guiding their organizing practice.
- Funders' Seminar—CRCP hosted a two-day seminar for its funding partners aimed at examining the issues of bringing reflective practice into grant-making organizations, and reviewing tools and strategies for supporting reflective practice among grantees.
- Waitt Foundation grantee reflection and learning process—CRCP designed an approach for foundation directors and grantees to develop a context for reflection and learning from their partnership.
- Rockefeller project: Reflection on building racially inclusive democratic participation in communities—The center carried out the planning stage of a project to document the work of five community organizations involved in grassroots democracy-building work.
- Community Practice Exploratorium—CRCP conducted its first annual open forum showcasing the work, knowledge, and products that emerged from the year's seminars, studios, and fellowships. The exploratorium is open to DUSP students and faculty, funders, participants in the reflective practice seminars and members of our partner communities.
- Research and development—Research fellows Jass Stewart from Invent Media Corp and Thenmozhi Soundararajan from Third World Majority completed initial development of an online tool that will support the creation, storage and sharing of digital stories for communities, as well as support the use of digital stories for reflection and knowledge sharing. StoryLink is a multimedia tool that provides the infrastructure for individuals and communities to create, share, and network through their digital stories.
- Springfield Design Studio—The design studio provides opportunities for students from MIT to work with community residents on specific problems. This year, two workshop courses were offered as part of the studio. One assessed the available agency database that could be used to build a community information system. The other built the first health risk assessment layer for the community GIS system.

Research Funding

Faculty raised $512,989 in new funds for the following projects.

Faculty received funding from the Alliance for Global Sustainability (AGS) for a variety of projects. Professor Polenske received $29,000 to research the impact of yellow dust and its economic and health effects in China, Korea and Japan. She also has an AGS grant for $61,000 to study energy-efficient and low-pollution technologies in China. Professor Lawrence Susskind and Research Scientist David Laws received $40,000 of a larger AGS grant funding an examination of breakthroughs in the systems of sustainable technologies. They also have a $25,000 grant for the Wisconsin-Netherlands Environmental Learning Project, funded by the Wisconsin Department of Natural Resources.

CMI has funded a joint project with the Cambridge Department of Land Economy and Professor Bernard Frieden and research scientist Christie Baxter. MIT's portion is $221,989 over two years for "Creating Places for Enterprise Development."

Professor Klopfer received $22,000 from the committee that administers the Class of '51 Fund for Excellence in Education, the Class of '55 Fund for Excellence in Teaching, and the Class of '72 Fund for Educational Innovation for the Teacher Education Program Undergraduate Initiative.

Research scientist Thomas Piper was granted $24,000 from the *Boston Globe* for the Beyond the Big Dig project.

For the seventh funding cycle, the department received $90,000 from the federal Department of Housing and Urban Development to support minority and economically disadvantaged graduate students. However, we have recently learned that MIT will not be able to continue receiving funds from this program.

Leadership Transition

After eight years of leadership, Professor Sanyal is stepping down as department head. He is succeeded by Professor Vale, a Margaret McVicar Faculty Fellow and associate head for the past two years. Ford professor Langley Keyes joins the leadership team as associate department head.

Bish Sanyal
Department Head
Professor of Urban Planning

More information about the Department of Urban Studies and Planning can be found on the newly redesigned web site at http://dusp.mit.edu/

Center for Advanced Visual Studies

The Center for Advanced Visual Studies (CAVS) is an art-based laboratory for collaborations between artists, scientists, and technologists. These collaborations are typically built around projects undertaken by resident Fellows, who also conduct seminars and supervise student participation. An emerging mission of the CAVS is the exploration of the digital arts as a common ground for collaborative projects. Our goal is the creation of important art that could not or would not be possible except at MIT.

Activities of fellows and affiliated faculty during 2001–2002 included:

- Fellow Hisham Bizri produced a 34-minute film entitled La Rencontre, in collaboration with MIT students. He continued work on his multimedia installation "Nostos" based on Joyce's Ulysses.
- Fellow Naoko Tosa joined the center during the year, and is working on several artificial intelligence-based systems that sense the viewer's emotional state in order to shape the interactive experience.
- Fellow Ioannis Michaloudis, a Fulbright scholar, has been studying the artistic potential of aerogels, and working on his multimedia play "(Nob)Odyssey."
- Fellow Seth Riskin was invited to present "Light Dance" performances on seven occasions, including a new piece for the Kepes Memorial Event at Kresge Theater, MIT, in June.
- Fellow Elizabeth Goldring has been developing a portable non-laser version of her "seeing machine" to present images to visually-challenged people. In June, her retinal images were exhibited at MIT's Compton Gallery.
- Director emeritus Otto Piene participated in five overseas exhibitions, including a 34-year 23-room retrospective entitled "Otto Piene—The Zero Experience," at the historic City Gallery of Prague, Czech Republic. At CAVS, he is organizing center documentation for 1968 to 1994 as preparation for a documentary volume, and making plans for a Sky Art Conference to be held at the island of Ikarea, Greece, in October 2003.

Educational Activities

Glorianna Davenport and Steve Benton conducted a fall-term seminar series in the CAVS conference space. The subject, entitled MAS.878 Experiences in Interactive Expression, brought the artists Vit Havrank, Daniel Rozin, Ben Rubin, Jonah Bruckner-Cohen, Ellen Sebring and Chris Csikszentmihályi to MIT for a day of discussions with students and faculty. At the end of the fall semester, an exhibition of student-produced interactive installations was presented at CAVS.

Fellow Hisham Bizri conducted a spring-term weekly seminar, MAS.879A Themes in Cinematic and Computational Art, with undergraduate and graduate students.

Fellow Seth Riskin conducted a spring-term weekly seminar/studio, MAS.879B The Culture of Light.

A total of eighteen MIT students joined CAVS as UROPs during this year.

Personnel

Artists Christine Sommerer and Laurent Mingnonneau were resident at CAVS for two months.

S. A. Benton
Director
Allen Professor of Media Arts and Sciences

More information about the Center for Advanced Visual Studies can be found on the web at http://cavs.mit.edu/.

Media Laboratory

In a year that saw tragic acts of terrorism trigger reflection about how little the world's people know about each other, the Media Laboratory continued to look outward, examining ways that digital technologies can contribute to a connected world population. As part of this effort, on September 20, 2001, the Lab signed a one-year research agreement with the Government of India to create Media Lab Asia (MLAsia), a nonprofit entity focused on developing sustainable and culturally appropriate solutions for improving health-care delivery, connectivity, and economic development for some of the world's poorest and most remote populations.

Back in Cambridge, the lab focused on what it means for us to identify ourselves, not only as members of a family, a town, or a country, but also as citizens of a global, online community. In October, some 500 attendees participated in ID/entity, a one-day symposium hosted by award-winning Dateline NBC correspondent John Hockenberry. The event focused on the effects of technology on the nature of identity in the twenty-first century—a time when we must ask ourselves not only "How is technology changing the world around us?" but also, "How is technology changing who we are and how others perceive us?"

Research Achievements

A sampling of 2001–2002 Media Laboratory research accomplishments includes:

—DonkeyNet, which brings Internet connectivity to even the most remote areas of the world by attaching a low-cost, handheld PC, equipped with a wireless card, to the back of a bus, delivery van, or even a donkey. Villagers queue their Internet messages at local telekiosks, and when the vehicle gets within range, the wireless radio link picks up the queued messages and drops off files for users of that kiosk.

—Responsive window technology, which turns any ordinary window into an interactive display using contact piezoelectric pickups that record the arrival of bending waves created when someone taps on the window.

—"Smart" building technology, which takes information technology out of conventional computers and literally builds it into components of buildings, allowing logical intelligence in a structure to grow along with its physical form.

—Impromptu, a new concept in mobile audio devices that utilizes the availability of portable computation and wireless Internet connection to allow you to enjoy a selection from your audio book collection, listen to your favorite music, get timely news updates, call your sister, or monitor your sleeping baby—all through a single audio device.

—A prototype for a hand-held, human-powered generator that creates five watts of power by being twirled over a person's head on a string. The device has implications for providing affordable power for simple computers in the remote areas of the globe where no electricity is available.

—Wearable computing, which allows us to move beyond PCs and laptops and wear our computers as we would eyeglasses or clothing. One project, MIThril, combines light-weight RISC processors, a single-cable power/data "body bus," and high-bandwidth wireless networking in a package that is nearly as light, comfortable, and unobtrusive as ordinary street clothing.

—A pack of 3-D animated autonomous and semi-autonomous synthetic wolves, who interact with users, exhibiting social behavior and acting much as real wolves do in their natural environment. The installation provides a first step in designing computer programs that allow people to get into the "mind and body" of another species.

—A robotic sea anemone-like creature to help us learn what aesthetic, behavioral, and interactive qualities give a robot a life-like presence, and how people relate to an "alien" creature that seems organic but is not anthropomorphic.

—Every Sign of Life, which explores the use of computer games to make monitoring personal health fun and engaging.

—New ways of joining the physical environment and cyberspace by making "tangible bits" accessible through everyday physical surfaces like walls or desktops. One project, Illuminating Clay, provides landscape designers with a new design tool that combines a sophisticated landscape-analysis computer program with a malleable clay model, allowing designers to immediately understand the implications of their designs in the real world.

—Autonomous agents capable of having a real-time, face-to-face conversation with a human. These agents are human in form and communicate using both verbal and non-verbal modalities.

—Toy Symphony, a three-year project involving children, soloists, composers, and symphony orchestras around the world, which aims to radically alter how children are introduced to music, and to redefine the relationship between professional musicians and young people.

Collaboration within MIT

The Media Laboratory continues to vigorously engage in collaborations within MIT. These collaborations are in the form of joint academic appointments, teaching efforts, and research programs. Some 18 percent of the graduate students supported by the lab and directly supervised by the Program in Media Arts and Sciences (MAS) faculty are from departments other than MAS. As in years past, the lab engaged almost 10 percent of the undergraduate student

population through the UROP program, and had 22 students enroll in the alternative freshman program, now in its third year.

Media Labs Abroad

Media Lab Europe

Media Lab Europe (MLE), launched in Dublin in 2000, experienced a year of substantial growth in FY2002. In January it hosted Extreme Interfaces, a one-day symposium and open house focused on new opportunities emerging from the convergence of minds and media. It also hosted the Eurographics Ireland 2002 Workshop organized by MLE's Synthesis group and Trinity College, Dublin, (which featured Media Lab's AT&T Career Development Professor Justine Cassell as keynote speaker), and the International Conference on New Interfaces for Musical Expression (NIME) in May. In FY2002 MLE also announced the formation of its first industry focus group, Future of Wireless. MLE also collaborated with Tod Machover on the Toy Symphony's world premiere in Dublin in April.

MLE Research Partners are AIB Group, BBC, eircom, Ericsson, Essilor, and Fondazione Ugo Bordoni. Donors include Denis O'Brien, Compaq, Hewlett Packard, Heidrick and Struggles, and Motorola.

Media Lab Asia

The Government of India and MIT signed an agreement in June 2001 establishing Media Lab Asia (MLAsia) in India. In September, a follow-up research and collaboration agreement was signed setting terms for a first-year "preparatory period," for the Indian government, MIT, industrial partners, and NGOs to work together to adapt the Media Lab model to the Asian context. MLA's goal is to find innovative ways for the newest technologies to have a favorable impact on the lives of some of the world's neediest people. With administrative headquarters in Mumbai, MLAsia is also supporting research labs on the campuses of the Indian Institutes of Technology of Bombay, Madras, Delhi, Kanpur, and Kharagpur. Media Lab Asia also deploys its technologies in participating grassroots communities.

In June 2002, Bimal Sareen was named MLAsia's CEO and managing director, as well as a member of MLAsia's board of directors. Sareen previously served as Compaq Computer Corporation's director of business and corporate development for the Asia-Pacific and Greater China regions.

Sponsors

In FY2002, funding for the lab's research programs remained level, with a larger portion of income coming from directed research sponsorship.

Research Sponsors

Approximately 15 proposals for new, government-directed research were submitted by the Media Lab in FY2002. While most remain under consideration, two have been awarded: "Center for Bits and Atoms" (Professor Neil Gershenfeld), from the National Science Foundation, and "RF Biomolecules—Direct Electronic Programming and Control of Bio-Molecular Machines" (Professor Joseph Jacobson), from DARPA/Air Force Research Laboratory.

Corporate and Strategic Research Partners

The lab acquired a new corporate research partner, the Hewlett-Packard Company, and a new strategic research partner, Korea's Information and Communications University. Both are accorded membership in all the lab's consortia and special interest groups.

Consortia

The last months of FY2002 saw the establishment of Changing Places, a joint Media Lab and Department of Architecture consortium, which explores how new technologies, materials, and strategies for design can make possible dynamic, evolving places that respond to the complexities of life. It is an expansion of the MIT House_n consortium.

Sponsors joining the Lab's consortia include:

- Changing Places: International Paper
- Digital Life: Banco Bradesco, NTT Comware, Stan Winston Studio
- Digital Nations: Banco Bradesco, INCAE, Try Group, SENACYT
- information: organized: U.S. Department of Defense
- Things That Think: FEI Company, Fraunhofer e.V., Yamaha Corporation

Also during FY2001, Varian, Inc. became an affiliate sponsor of the lab and Informatix, Inc. contributed to the lab's endowment funds.

Special Funds

Nine corporate sponsors—BT, eircom, IBM, Intel, LEGO, Mattel, Motorola, Telmex, and Toshiba—funded fellowship programs. Additional sponsors include the family and friends of the late Steven R. Holtzman, who established a fellowship in his memory; Media Lab Europe; and Media Lab Asia. The following were named fellows during FY2002:

- BT: Aggelos Bletsas, Brian Chow, Marc Downie, Thomas J. McLeish, Paulo Rocha e Oliveira, and Edison Thomaz
- eircom: Wei Chai, Constantine Christakos, Aisling Kelliher, Joshua Lifton, Andrea Lockerd, and Sean Wheeler

- Steven R. Holtzman Fellowship for Digital Expression: Nikita Pashenkov
- IBM: Mark Feldmeier, Raul Fernandez, Vadim Gerasimov, Kai-Yuh Hsiao, Karrie Karahalios, Maxim Shusteff, Brygg Ullmer, and Sunil Vemuri
- Intel: danah boyd, Leo Burd, Peter Gorniak, Benjamin Vigoda, and Dimitris Vyzovitis
- LEGO: Michelle Hlubinka, Michael Rosenblatt, and Claudia Urrea
- Mattel: Catherine Vaucelle
- Media Lab Asia: Anindita Basu, Rahul Bhargava, Sheel Dhande, Nathan Eagle, Ashish Kapoor, Vikram Sheel Kumar, Nyssim Lefford, Geva Patz, Nitin Sawhney, and Ramesh Srinivasan
- Media Lab Europe: Margarita Dekoli, Ali Mazalek, Florian Mueller, and Benjamin Piper
- Motorola: Barbara Barry, Rich Fletcher, Hong Ma, Cameron Marlow, Rehmi Post, Matt Reynolds, and Cagri Savran
- Telmex: Georgina Echániz-Pellicer, Marco Escobedo, Daniel Kornhauser, Marco Monroy, Emmanuel Munguia-Tapia, Wilfrido Sierra, and Gerardo Vallejo
- Toshiba: Ari Benbasat, Angela Chang, and Rich DeVaul

New Corporate Visitors and Affiliates

During FY2002 Gerardo Lucio Casas from Telmex, and Marshall Millier from Intel, were appointed research affiliates, and Nanako Ishido from CSK was appointed visiting scholar.

Personnel

In its most difficult personnel decision since opening its doors in 1985, the lab announced layoffs of some 30 employees in December 2001. The layoffs were part of a lab-wide effort to bring an exponential growth in expenses in line with its linear growth in revenues. The cuts were made mostly in management and support positions, ensuring that they would not affect the depth or breadth of any of the lab's research programs.

Earlier in 2001 two new positions had been created: Ramona Allen, who previously worked at MIT's Department of Biology and Human Resources Office, was appointed as the lab's director of human resources, and Amy Holden was appointed as coordinator for the Media Lab Europe collaboration.

Walter Bender
Executive Director

More information about the Media Laboratory can be found on the web at http://www.media.mit.edu/.

Media Laboratory Sponsors

*Corporate and Strategic Research Partners**

BT
Hewlett-Packard Company
Information and Communications University
Intel
Learning Lab Denmark
The LEGO Group
MasterCard International
Motorola, Inc.
Swatch AG
Telmex
US Postal Service
*Members of all consortia and special interest groups

Research Consortia

Changing Places
International Paper

Digital Life (DL)
Acer Incorporated
Banco Bradesco
Bertelsmann AG/BMG Entertainment
Deutsche Telekom AG
Eastman Kodak
eircom
Ericsson
France Telecom/Orange
Hallmark Cards, Inc.
Harman International Industries
Industrial Technology Research Institute
McDonald's Corporation
Merrill Lynch
Minnesota Mining & Manufacturing Co.
Nortel Networks
NTT Comware
Panasonic Technologies Company
Philip Morris Companies, Inc.
Royal Ahold
Sprint/United Management Company
Stan Winston Studio, Inc.
Telecom Italia LAB
TOPPAN Printing Co., Ltd.
Viant Corporation
WPP Group plc

Digital Nations
Banco Bradesco
INCAE
SENACYT
Try Group, Inc.

information: organized (i:o)
AARP
Eastman Kodak
Grupo Estado
International Business Machines

International Olympic Committee
Interpublic Group
JCPenney
Johnson & Johnson
McGraw-Hill
Sun Microsystems
Time Inc. Production
US Department of Defense

Things That Think (TTT)
American Greetings Corporation
Amgen, Inc.
Becton, Dickinson and Company
Brother International Corporation
ChevronTexaco Information
Technology Company
Consignia plc
DaimlerChrysler
DuPont
EDS
Escher Group, Ltd.
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Ford Motor Company
Fraunhofer e.V.
General Motors Cyberworks
Kaiser Foundation Health Plan, Inc.
Lear Corporation
Lucent Technologies
Mars, Incorporated
Mattel, Inc.
Microsoft Corporation
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NEC Technologies, Inc.
Nokia Corporation
Pitney Bowes, Inc.
Roche Diagnostics Corporation
Saab AB
Schott Glas
Sensormatic Electronics Corp.
Shell Oil Company
Steelcase Inc.
Sun Microsystems
Telenor R&D
Tomy Company, Ltd.
Toshiba
Unisys Corporation
Yamaha Corporation

Special Interest Groups

CC++
DaimlerChrysler
Ford Motor Company
General Motors
Lear Corporation

Counter Intelligence
Royal Ahold

e-markets
Acer Incorporated
ChevronTexaco Information
Technology Company
eircom
Kraft Foods, Inc.
Merrill Lynch
Royal Ahold
Gray Matters
AARP

Silicon Biology /Personal Fabrication/ IPID
Agfa-Gevaert
DuPont
Lucent Technologies
Roche Diagnostics Corporation
Sensormatic Electronics Corp.
TOPPAN Printing Co., Ltd.
Toshiba

Toys of Tomorrow (TOT)
Deutsche Telekom AG
International Olympic Committee
Mattel, Inc.
Tomy Company, Ltd.

Special Funds

Alma Media
ASCII Corporation
BT
CSK Corporation
Heller Werkstatt
Intel
International Business Machines
The LEGO Group
Mattel, Inc.
Media Lab Asia
Media Lab Europe
Motorola, Inc.
NTT Comware
SEGA
Sony Corporation
Telmex

Research Contracts

France Telecom/Orange
Microsoft Corporation
National Science Foundation
US Air Force
US Defense Advanced Research Projects Agency
US Department of the Army

Affiliates

Accenture
Datalogic S.p.A.
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Endowment and Naming Grants

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MasterCard International
Misawa Homes
Motorola, Inc.
NEC
Isao Okawa
Schlumberger
Sony Corporation
Swatch AG
Telmex
Toshiba
Philippe Villers

June 2002

Center for Real Estate

The Center for Real Estate (MIT/CRE) was founded in 1984. The mission of the center is to improve the quality of the built environment through education and research and by facilitating communication among members of the real estate industry worldwide. To this end, it carries out teaching and research programs in the field of real estate development, investment, and management. It also provides a forum for the exchange of information and the discussion of issues by real estate professionals from around the world. The center's principal activities include an 11-month professional degree program leading to a Master of Science in Real Estate Development (MSRED) and a research agenda of issues relating to the planning, development and management of real estate, including its financial performance.

Education

Twenty-eight members of the Class of 2001, the seventeenth class of MSRED graduates, received their SM degrees in real estate development in September 2001. Three members of the class had completed their requirements and received their degrees earlier, in either February or June of 2001, and two others will receive degrees upon completion of their academic requirements. The 32 members of the incoming Class of 2003, which includes five joint degree candidates, were selected in April from an applicant pool that was both strong and the largest in several years. The new class of eight women and 24 men includes seven international students. Two incoming students already hold advanced degrees in architectural studies and city planning.

The center is fully supporting one ongoing PhD candidate jointly in the Departments of Economics and Urban Studies and Planning.

The 28 members of the MSRED Class of 2002 had several new course options in 2001–2002. The subject 15.941 Managing in the Real Estate Industry was dropped as a core course. Instead, students could satisfy the management requirement through offerings in the Department of Civil and Environmental Engineering and the Sloan School of Management. A new real estate-focused management seminar 11.945/15.922 Beyond the Number: Managing Successful Deals was offered by Gloria Schuck, lecturer in the Department of Urban Studies and Planning. The subjects 11.431J Real Estate Finance and Investment, and 11.432.J Real Estate Capital Markets were not offered in 2001–2002 while associate professor Timothy J. Riddiough, in the Department of Urban Studies and Planning, was on sabbatical. They will be offered again in 2002–2003. Instead, MSRED students took both 15.401 Finance Theory I, and 15.402 Finance Theory II, as well as a new two-term seminar, 11.921/11.922 Real Estate Finance, designed to complement the finance theory courses.

Associate professor Riddiough accepted a position at the University of Wisconsin. A faculty search during spring term led to the hiring of David Geltner, recently a professor of real estate at the University of Cincinnati. He earned his PhD at MIT in 1989. He is expected to teach the courses previously taught by Riddiough.

Research

Center faculty are engaged in a number of research projects. Professor of economics William C. Wheaton has been researching the causes and consequences of the spatial dispersion of jobs in cities throughout the world. His model explaining the process through which wages for identical workers vary by where they work is described in a working paper. Professor Wheaton is also working on several papers studying the influence of metropolitan government structure on the performance of real estate markets. In a joint paper with Professor Bengte Evenson (Indiana), he argues that metropolitan areas with numerous small jurisdictions have a greater incentive to set aside land from development, which drives up the long-term price of housing. Henry Pollakowski, visiting scholar in the Department of Urban Studies and Planning, is continuing work on a model projecting state sales tax losses due to Internet retail sales. He has begun a follow-up to his study of the effects of rent decontrol in Cambridge and Brookline.

The center hosted visiting scholar Joo Hyun Cho, a real estate capital markets specialist, for this year and continued to host housing economist and editor of the Journal of Housing Economics Henry Pollakowski for a sixth year.

Professional Education

The seventeenth summer of professional development courses brought 453 attendees to campus in June and July of 2001, a substantial increase from the previous summer's attendance. Attendees enrolled in eight courses, including two new courses, "Innovations in Real Estate Finance," taught by Associate professor Riddiough and "Benchmarking: Real Estate Investment Management and Performance Measurement," taught by Professor David Geltner of the University of Cincinnati, both of which were very well received. A second section of the ever-popular "Fundamentals of Real Estate Finance" ran in late July and garnered a good enrollment simply by overflow from the first section and word of mouth. Professional development courses for the summer of 2002 include two new courses. Associate professor Riddiough will teach a two-day course in "Commercial Real Estate Debt," and Sandra Lambert, lecturer in the Department of Urban Studies and Planning will present "Negotiation in the New Real Estate Context."

Membership

Income from membership declined as the center closed the year with 58 supporting members (including five international members). This represents a net loss of ten members from the previous year. Membership fees and benefits were restructured to provide an additional level of individual membership at a lower cost. It is expected that many MSRED alumni will find it more possible to join as individuals at that level. In addition to annual fees, many members supported the center in non-financial ways by providing case study sites, lecturing in class, and supporting student thesis work. For a sixth year, Robert Danziger, retired chairman of member firm Northland Investment, organized and led the well-received Real Deals speaker series.

The center hosted a lively meeting in November for corporate supporters, current students, faculty, and, for the first time, members of the public. The topic of the symposium was trends affecting the commercial brokerage sector of the industry, which has undergone rapid consolidation and globalization in the last five years. The dinner speaker was Andrew Farkas, chairman and CEO of the rapidly expanding Insignia Financial Group and a somewhat controversial figure in the industry. The following morning, the heads of leading brokerages, sitting as a panel moderated by University of Pennsylvania faculty member Terrence LaPier, wrestled with a series of topics including motivating and compensating employees, pricing services, the decline of entrepreneurship, and the recession and the future.

In May, the center's spring symposium, Smart Growth: What's Behind the Rhetoric?, attracted a larger group of attendees than usual. Parris Glendening, the governor of Maryland, a former university professor and long-time advocate of growth management, led off the meeting by explaining how his state has implemented incentives aimed at targeting growth to established areas and preventing sprawl. The program the following morning included many well-known advocates and critics of growth management, including Stuart Meck, principal investigator of the American Planning Association's Growing Smart project and Minnesota state senator Myron Orfield, an expert on the demographics and politics of the suburbs. Audience members took part vigorously in the discussion session following the presentations.

Administration

John T. Riordan, former president of the International Council of Shopping Centers, and well known in the real estate industry, officially assumed the chairmanship of the center in July 2001. The director, Professor William C. Wheaton, and associate director Marion Cunningham continued in their posts this year.

The refurbishing of the center's quarters continued with a face-lift of the student lounge and adjoining conference room. New carpet, paint and furniture created a warmer and fresher environment for students and visitors. The project was initiated by a gift from the Class of 2000 and benefited by continuing design leadership by members of that class. The center's web site is also in the midst of a redesign. The finished site should be ready by the middle of July 2002. The web remains the primary source of inquiries by the public about the MSRED program, professional development courses, and working papers.

William C. Wheaton
Director
Professor of Economics

More information about the Center for Real Estate can be found on the web at http://web.mit.edu/cre/.

Dean, School of Engineering

By creating, developing, organizing, and managing complex technologies and products, engineers play a crucial role in shaping our world. Engineers seek solutions to the most difficult challenges of our day in the context of physical, economic, human, political, legal, and cultural realities. In a world increasingly influenced by scientific and technological innovation, engineers can, and do, contribute vital leadership to society.

Leadership, Technical Excellence, Innovation

Through education, research, outreach, and service, MIT's School of Engineering develops future technological leaders, advances the frontiers of engineering knowledge, and imprints engineering practice. Building on an unparalleled tradition of achievement and a passion for excellence, the School is shepherding the next generation of engineering innovation.

Currently, the School's eight departments and two divisions encompass a community of many of the world's brightest minds and most inventive thinkers—about 60% of MIT's undergraduates with declared majors, about 45% of MIT graduate students, and over one-third of the Institute's faculty. Third-party ratings routinely rate the School's departments as the best in their fields.

During academic year 2001–2002, the School undertook several major initiatives that underscore its commitment to maintaining leadership in shaping engineering education and research. This report presents selected highlights of significant achievements of the School. It also includes updates on notable awards, personnel changes, and School statistics. The reports of the School's departments, divisions, laboratories, centers, and programs provide additional information about their activities over the past year.

Continuing Initiatives

The School strives to make significant contributions to addressing the societal challenges of the 21st century by pursuing a course of leadership through technical excellence and innovation. It has identified seven programmatic themes for special emphasis:

- bioengineering
- information engineering (information, computation, and communication)
- engineering systems
- tiny technologies (miniaturization, microtechnologies, and nanotechnologies)
- next-generation technologies
- innovations in education that include the use of new technologies
- increasing faculty diversity

By emphasizing these themes, the School aspires to set the direction and create new models for engineering education and research.

This report provides examples of both continuing and new educational, research, and service initiatives. Separate reports or web sites provide additional detail.

iCampus

Named "Project iCampus," the alliance between MIT and Microsoft Research begun in late 1999, is now in its third year. To date, iCampus has sponsored over 30 cooperative projects among members of Microsoft Research and students, faculty, and researchers at MIT, particularly in Engineering. In addition to those projects that MIT faculty have proposed and managed, iCampus has awarded more than $750,000 to projects run by MIT students, both undergraduate and graduate.

Industrial Partnerships

Historically, industrial research collaborations undertaken by MIT and the School of Engineering have created new knowledge and transferred science and technology into industry, resulting in the creation of jobs, companies, and even new industries based on new technologies. In recent years, MIT has become a leader in developing research and education partnerships with industry, many anchored in the School of Engineering. Some of the School's most significant industrial relationships include:

- MIT/Hewlett-Packard Alliance in Digital Information Systems
- Merrill Lynch-MIT Partnership in Financial Technology
- The Ford-MIT Alliance for the betterment of engineering, education, and the environment), and
- The Nippon Telegraph and Telephone Corporation (NTT) partnership with MIT for new technologies in telecommunication and computers.

At this time, MIT draws 20% of the research volume at MIT from industry, and the School is actively pursuing increased collaboration with industry.

Lemelson-MIT Program

On July 1, 2001, the Lemelson-MIT Program moved from the Sloan School of Management to officially join the School of Engineering. now in its 8th year, the Lemelson-MIT Program is a nationwide educational initiative whose mission is to generate excitement about invention,

innovation, and entrepreneurship through its annual awards and outreach activities. As in the past, this year the program awarded the $500,000 Lemelson-MIT Prize for Invention, the Lemelson-MIT Lifetime Achievement Award, and the $30,000 Lemelson-MIT Student Prize. In addition to granting these awards, the program instituted InvenTeam grants to support a non-competitive, team-based approach to invention and innovation among high school students.

OpenCourseWare

In April 2001, MIT launched OpenCourseWare (OCW), a new initiative to make nearly all of MIT's course materials freely available on the World Wide Web. Soon after, MIT announced the award of two grants, totaling $11 million, to MIT OCW by the Andrew W. Mellon Foundation and the William and Flora Hewlett Foundation for the first 27-month pilot phase of OCW. Building on the seminal role the School of Engineering played in OCW's conception, development, and adoption by MIT, engineering faculty members have continued to provide leadership for this initiative. An OCW Transition Project Team developed twenty pilot web sites by spring 2002. The School of Engineering sees MIT OCW as having the potential to lead to fundamental changes in the way colleges and universities use the web as a vehicle for education.

Singapore-MIT Alliance

Through its involvement with the Singapore-MIT Alliance (SMA), a collaboration among MIT, the National University of Singapore (NUS), and Nanyang Technological University (NTU), the School is pioneering an innovative approach to global engineering education and research. Founded in late 1998, SMA utilizes advanced communications technologies and, stretching across 12 time zones, has developed into the world's most technologically advanced point-to-point synchronous educational program.

This year, SMA held its first commencement in July 2001 and its second anniversary in January 2002. It grew from three graduate degree programs to five and continued to increase the number of research collaborations in engineering science and new technologies. Forty-four MIT faculty from eight departments and three schools, i.e., more than 10% of MIT's faculty, worked collaboratively with 46 Singaporean colleagues to provide graduate education and research supervision to 146 SMA students. Many SMA courses are also offered to MIT students. More than 440 MIT students have participated since September 1999.

Cambridge-MIT Institute

A collaborative program between MIT and Cambridge University instituted in 2000, the Cambridge-MIT Institute (CMI) undertakes joint educational and research initiatives that improve entrepreneurship, productivity, and competitiveness in the UK. CMI sponsors a student-exchange program for undergraduates, as well as curriculum development for faculty members. A growing number of MIT School of Engineering departments are sending and receiving students through the exchange program. In 2001-2002, 27 MIT juniors attended Cambridge University while 33 Cambridge students attended MIT. CMI also funds undergraduate research opportunities for students, including a shared Undergraduate Research Program beginning as a pilot in the summer of 2002. To stimulate innovation, CMI held more than 40 workshops last year for turning innovative research into new enterprises and products. Professors and researchers from both universities have undertaken joint research projects in a wide range of areas, including nanotechnology, quantum information theory, and low-energy building design.

New Initiatives

The School launched major new initiatives in technological innovation, nanotechnology, and engineering education innovation.

Deshpande Center for Technological Innovation

Building on the previous year's IdeaStream conference that reached out to the venture capitalist and entrepreneurial communities, the School this year launched the Deshpande Center for Technological Innovation. The Deshpande Center supports leading-edge research on emerging technologies at MIT and cultivates interactions between the Institute and innovative companies and entrepreneurs in the high tech community.

Institute for Soldier Nanotechnologies

In March, the Army selected MIT for a five-year, $50 million initiative as an Institute for Soldier Nanotechnologies (ISN) anchored in the School of Engineering. The goal of the ISN is to greatly enhance the protection and survival of future infantry soldiers using nanoscience and nanotechnology to create lightweight uniforms with novel functionality. As founding industrial partners, Raytheon, DuPont, and Massachusetts General/Brigham and Women's Hospital will work closely with the ISN and with the Army Natick Soldier Center and the Army Research Laboratory, Aberdeen, Maryland, to advance the science in field-ready products. ISN will have a staff of up to 150 people, including 35 MIT professors from nine departments, largely in the School of Engineering, as well as in the Schools of Science and Architecture and Planning, and 80 graduate students and 20 postdoctoral associates.

Undergraduate Practice Opportunities Program

In the past year, the School initiated a new Undergraduate Practice Opportunities Program (UPOP) to offer undergraduates preparation and experience in engineering practice. As described later in this report, this program involves a collaboration among industry and faculty from both Engineering and Management.

Diversity

Building and Strengthening a Diverse Community

The School has a long-standing commitment to build a community of faculty, students, and staff that is both world-class and diverse. It continues to actively pursue these goals and has made increasing diversity one of its major priorities for the future. The School has been working to explore, develop, and implement a range of programs and services that create an environment that promotes and achieves student and faculty diversity. In support of underrepresented minority students, the School this year began a new program for local high school students, the Saturday Engineering Enrichment and Discovery (SEED) Academy (see below).

The groundbreaking 1999 report on the status of women in the School of Science has had great impact at the national level, at the Institute, and in our School as well. In January, our campus served as host to a conference of minority women science and engineering faculty from around the country. The National Initiative on Minority Women Faculty conference convened to discuss solutions to gender- and race-based career barriers, pipeline issues relating to hiring of faculty, and tools for enhancing the diversity of the academic community. Such discussions provide vital information and serve as a catalyst for continuing progress toward achieving greater diversity among our faculty.

Committee on the Status of Women Faculty in the School of Engineering

In March 2002, the Committee on the Status of Women Faculty in the School of Engineering, chaired by Lorna J. Gibson, professor of materials science and engineering, completed its report and presented it to the MIT Faculty, as did similar committees in the other schools. Other members of the School of Engineering committee were Professors Mary C. Boyce, Sallie (Penny) Chisholm, Edward F. Crawley, Karen K. Gleason, Nancy A. Lynch, and John B. Vander Sande. The report represents two years of research, initiated following the report on the status of women in the School of Science. The committee examined a number of data and interviewed virtually all the women faculty in the School. It focused its report on five main areas: faculty numbers, women in positions of academic leadership, promotion and tenure rates, salary, and marginalization—the exclusion from full participation in a department's academic life.

Both across the Institute and in the School of Engineering, identification of issues through the work of the faculty gender equity committees has resulted in proactive initiatives and systemic progress on several fronts, including: the appointment of a number of women professors to academic leadership positions, increases in the number of women on the faculty, a more collegial environment, development of guidelines for hiring practices, and new family/work policies. In addition, the School hosted a workshop on diversity led by Professor Virginia Valian of Hunter College. This workshop examined factors leading to gender inequity and presented reasons why gender equity is desirable for an institution.

Despite these changes, additional improvements are required, especially to address issues of marginalization. Accompanying the study findings, the new report offers further recommendations for innovations in recruiting, hiring, and promotion policies.

Special Programs

The School of Engineering currently offers four special programs.

Minority Introduction to Engineering, Entrepreneurship, and Science (MITE²S)

This year the MITE²S program selected 64 underrepresented minority high school seniors to participate in its rigorous six-week session. Chosen from over 550 applications, the selected students come from 25 states and Puerto Rico. The program enhanced courses in robotics and in Internet programming introduced in 2001. Reflecting the more diverse professional interests of the students, this year's session provided opportunities for students to present both Internet applications and entrepreneurial ideas to the MIT community. A mix of corporations, foundations, MIT alumni, and parents of former participants has made major contributions in support of the 2002 session. Two new donors increased the program's endowments in pledges and gifts to $4.97 million, from $3.6 million in 2001. Of the 80 students who attended MITE²S 2001, MIT accepted a record 54 for admission as undergraduates. Thirty will attend MIT this year, also a record number.

Engineering Internship Program

During the summer of 2002, 17 students (down from 33 in 2001) will participate in Engineering Internship Program (EIP) internships: nine from Aeronautics and Astronautics, and 16 from Mechanical Engineering. Given an increase in choices among summer internships, summer jobs, and five-year master's programs available to School of Engineering students, the School began to phase out EIP in 2001-2002. No new sophomores were enrolled in 2002. Sophomores interested in the program were directed to enroll in the Undergraduate Practice Opportunities Program (UPOP).

Saturday Engineering Enrichment and Discovery (SEED) Academy

In the 2001-2002 academic year, the MITE²S Program launched an eight-week academic year Saturday program for 23 local minority ninth graders designed to strengthen fundamental mathematics, science, and communications

skills in the context of hands-on engineering projects. A corporation, a foundation, and an MIT alumnus provided outside funding for the first year of the program. At full capacity in 2004-2005, the SEED Academy will host 80 students from five Cambridge and Boston high schools.

Undergraduate Practice Opportunities Program (UPOP)

UPOP was created with the mission of better preparing MIT's engineering sophomores for the multi-faceted nature of engineering practice. The program consists of two major phases: the IAP Engineering Practice Workshop and the Summer Practice Experience. With assistance from engineering professionals, faculty from the School of Engineering and the Sloan School of Management delivered instruction for the IAP Engineering Practice Workshop on topics including robust engineering design, system dynamics, leadership, and communication. In its first year of a five-year, $2.5 million pilot funded by the Deshpande Center for Technological Innovation, UPOP had 73 student participants from seven engineering departments. The year's recruiting effort yielded over 50 participating Summer Practice Experience employers and resulted in 86% of UPOP students receiving internship offers from industrial firms. Throughout the spring term UPOP also sponsored several career development workshops that involved the participation of many MIT alumni.

Educational Developments

The School has continued to work with units in engineering education innovation and assessment under the leadership of associate dean Dick Yue, professor of ocean engineering. All but one of the School's programs recently received ABET accreditation until 2008 under the framework of new EAC accreditation criteria; one program, Environmental Engineering Science, received accreditation until 2004. To maintain the momentum of continuous improvement of education begun by ABET, the School has established a new Engineering Council for Undergraduate Education (E-CUE). E-CUE's mission is to bring units together in oversight of school-wide education improvement projects. One example of the group's work is to examine changing undergraduate major enrollment and how these changes reflect changing student demand for new interdisciplinary curricula and programs. Another related study will examine the role of the School in the freshman year as a means of attracting students to engineering. E-CUE has also begun working with the Dean of Undergraduate Education to create a new course evaluation survey that focuses on student learning.

Through E-CUE, the School joined with Cambridge-MIT Institute (CMI) staff in managing the development of a range of exciting CMI-funded engineering education projects including a Technopreneurship Academy, Robotworld, online material for connecting lecture and laboratory content, and a detailed comparison of learning under the MIT and University of Cambridge engineering education systems. E-CUE will continue to work with CMI in coordinating these efforts with the University of Cambridge Engineering Department. To meet program demand for a streamlined format for program and subject assessment, the School's education expert is in the process of creating on-line assessment tools that are specific to engineering education programs and subjects.

Personnel

Professor Rohan Abeyaratne, a Van Buren N. Hansford Faculty Fellow and the Quentin Berg professor, became department head of the Department of Mechanical Engineering, effective July 2, 2001.

In July, Professor Rafael Bras, the Bacardi-Stockholm professor, stepped down from the position of department head of the Department of Civil and Environmental Engineering and began a sabbatical leave, after having served in the position for nine years.

Professor Charles L. Cooney, a professor of chemical and biochemical engineering, became the faculty director of the new Deshpande Center for Technological Innovation on March 1, 2002.

Professor Merton C. Flemings, Toyota professor emeritus of materials processing, was named faculty director of the Lemelson-MIT Program effective July 1, 2001.

The director of the Technology and Policy Program, Daniel Hastings, professor of aeronautics and astronautics and professor of engineering systems, became the associate director of the Engineering Systems Division as of July 1, 2001.

Ms. Krisztina Holly was selected as the executive director of the new Deshpande Center for Technological Innovation on July 1, 2002.

Professor Steven Lerman, the Class of 1922 distinguished professor of civil and environmental engineering, was named the deputy director of the Singapore-MIT Alliance (SMA) as of January 1, 2002, succeeding Professor Anthony Patera, who became the MIT co-director of SMA the previous February.

Professor Barbara Liskov, Ford professor of engineering, became the associate department head from Computer Science in the Department of Electrical Engineering and Computer Science (EECS) in September.

Professor Chiang C. Mei, the Donald and Martha Harleman professor, served as acting department head in the Department of Civil and Environmental Engineering.

In July, Professor Warren Seering, the Weber-Shaughness professor and professor of mechanical engineering, stepped

down from his position as faculty director of the Center for Innovation in Product Development to begin a sabbatical leave.

Professor Nam P. Suh, the Ralph E. and Eloise F. Cross professor, stepped down as department head of Mechanical Engineering, effective July 1, 2001, to begin a sabbatical leave after serving in the position for 10 years.

Professor Edwin Thomas, Morris Cohen professor of materials science and engineering, was named the faculty director of the new Institute for Soldier Nanotechnologies.

Professor of electrical engineering and computer science Victor W. Zue, who had previously served as the associate director of the Laboratory for Computer Science (LCS) and subsequently the acting director of the lab following the untimely death of Professor Michael Dertouzos, became director of LCS, effective December 1, 2001.

Awards

Each year faculty of the School of Engineering receive numerous honors in recognition of their research and service, many offered by professional societies and the faculties' professional communities. This year was no exception. The reports of the School's departments, divisions, laboratories, centers, and programs make note of many of these awards. Several especially notable awards and School-based awards deserve additional mention here.

The National Academy of Engineering (NAE) elected five School of Engineering faculty and staff to membership: Professor Berthold K.P. Horn (SM 1970, PhD) of the Department of Electrical Engineering and Computer Science; Klavs F. Jensen, the Lammot du Pont professor of chemical engineering and professor of materials science and engineering; James C. Keck, the Ford professor of engineering emeritus and senior lecturer in the Department of Mechanical Engineering; Subra Suresh (ScD 1981), professor and head of the Department of Materials Science and Engineering; and Richard M. Stallman, a research affiliate in the Artificial Intelligence Laboratory and president and founder of the Free Software Foundation Inc. in Boston.

The American Academy of Arts and Sciences (AAAS) this year awarded the distinction of fellow to three Engineering faculty and staff: Felice Frankel, an MIT research scientist and science photographer in the Department of Electrical Engineering and Computer Science; James G. Fujimoto, professor of electrical engineering and computer science; and David D. Clark, senior research scientist in the Laboratory for Computer Science (LCS).

Tim Berners-Lee, the inventor of the World Wide Web and director of the World Wide Web Consortium in LCS, won the prestigious Japan Prize for 2002 in the field of computing and computational science and engineering. Awarded by the Science and Technology Foundation of Japan, the Japan Prize is given to scientists whose achievements contribute to the progress of science and technology and the promotion of peace and prosperity for mankind.

Robert Langer, the Germeshausen professor of chemical and biomedical engineering, received the 2002 Charles Stark Draper Prize, a $500,000 annual award and gold medallion often referred to as "engineering's Nobel Prize," for inventing medical drug delivery technologies that prolong lives and ease the suffering of millions every year.

Institute and School Awards for Achievement, Leadership, Contributions to Education and Service

The Institute awarded the Everett Moore Baker Memorial Award for Excellence in Undergraduate Teaching to Professors John G. Brisson, II, and Professor Ernest G. Cravalho of Mechanical Engineering. Given in memory of Everett Moore Baker, dean of students from 1947–50, this award is presented to faculty members in recognition of exceptional interest and ability in undergraduate instruction and is the only teaching award in which the nomination and selection of the recipients is conducted entirely by students.

The Amar Bose Award for Excellence in Teaching went to Professor Jesús del Alamo of Electrical Engineering and Computer Science (EECS). The award, established in 1989 by the School to recognize outstanding contributions to undergraduate education, is given annually to an engineering faculty member whose teaching contributions over an extended period are characterized by dedication, care, creativity and inspiration to students and colleagues.

The Junior Bose Award went to Professors David Darmofal of Aeronautics and Astronautics and Hari Balakrishnan of EECS. The award, established in 1995–96, recognizes teaching excellence by junior engineering faculty.

Four of the first eight Fellows of the Cambridge-MIT Institute (CMI) selected for 2001-2002 are engineering faculty members: Professor Rohan C. Abeyaratne of Mechanical Engineering; Professor Lorna J. Gibson of the Department of Materials Science and Engineering; Professor Daniel E. Hastings of Aeronautics and Astronautics, director of the Technology and Policy Program; and Professor Roger D. Kamm of Mechanical Engineering, appointed jointly with Professor Paul T. Matsudaira of Biology (both of whom are affiliated with the Biological Engineering Division). All of the eight new fellows were cited for roles they played during the formative stages of CMI.

Two of the Graduate Student Council Graduate Teaching Awards for excellence in teaching a graduate-level course, given each year to one professor or teaching assistant from each school went this year to Professors Kent F. Hansen of Nuclear Engineering and Manish Bhardwaj of the Department of Electrical Engineering and Computer Science.

Professor Paul E. Gray of EECS received a Leadership Award at the 28th annual Martin Luther King, Jr. Celebratory Breakfast in recognition for his service to the community. Professor Gray played a key role in establishing MIT's annual Dr. Martin Luther King Celebration when he was chancellor in 1975 and demonstrated his commitment to increasing opportunities at all levels for minorities on campus while he was MIT president from 1980 to 1990.

In recognition of his devotion to undergraduate education at the Institute, MIT named Professor Steven R. Hall of Aeronautics and Astronautics as one of five 2001–2002 MacVicar Faculty Fellows. The awards, given in memory of former dean of undergraduate education and professor of physics Margaret L. A. MacVicar, recognize faculty members' excellence in teaching and innovation in education.

The Institute awarded the Arthur C. Smith Award to Professor Linn W. Hobbs of Materials Science and Engineering. Established in 1996 on the occasion of Dean Smith's retirement from the position of dean for undergraduate education and student affairs, this award honors the service of Dean Smith. It is presented to a member of the MIT faculty for meaningful contributions and devotion to undergraduate student life and learning at MIT.

Professors David Cory of Nuclear Engineering, Rajeev Ram of EECS and David Trumper of Mechanical Engineering were awarded the Ruth and Joel Spira Award for Distinguished Teaching. The award is made possible by a gift from Ruth and Joel S. Spira to acknowledge "the tradition of high-quality engineering education at MIT." Awards are made each year to one faculty member in each of the three departments.

Awards Received by Engineering Students

The Association of MIT Alumnae (AMITA) Senior Academic Award is given to senior women who have demonstrated the highest level of academic excellence through coursework and related professional activities at MIT. This year two engineering students received honorable mentions: Tiffany S. Santos of the Department of Materials Science and Engineering and Emily M. Craparo of Aeronautics and Astronautics.

Ian J. Parrish of Nuclear Engineering received the Henry Ford II Scholar Award, given to a senior in the School of Engineering who has attained the highest academic record at the end of the third year and who exhibits exceptional potential for leadership in the profession of engineering and in society.

Engineering students received two of three Barry Goldwater Scholarships given to MIT students this year. The award honors students who exhibit outstanding potential and intend to pursue careers in mathematics, the natural sciences, or those engineering disciplines that contribute significantly to the technological advances of the United States. Terri Yu, a junior in Electrical Engineering and in Physics, and Bradley Olsen, a junior in Chemical Engineering, received the Goldwater Scholarships.

The Priscilla King Gray Award for Public Service went to Selam Daniel, a senior in Chemical Engineering from Arlington, Texas. The award was established by the Undergraduate Association and the Public Service Center to recognize an undergraduate exceptionally committed to public service at MIT and its surrounding communities. The recipient of this award clearly demonstrates a personal dedication to social change, as well as prolonged and in-depth involvement and initiative in a leadership capacity.

The Albert G. Hill Prize, awarded to minority juniors or seniors who have maintained high academic standards and made continued contributions to the improvement of the quality of life for minorities at MIT. Leonard J. Grant, a senior in the Department of Materials Science and Engineering and Kateri A. Garcia, a junior in Mechanical Engineering, received awards. A former vice president for research, Dr. Hill was an early champion of equal opportunity at MIT.

On behalf of the Hispanic Engineer National Achievement Awards Conference (HENAAC), we are proud to announce that Daniel Sandoval of Mechanical Engineering won the 2001 Hispanic Engineer National Achievement Awards Conference Student Leadership Award.

Graduate student Benton H. Calhoun was chosen to receive the first Infineon Technologies Fellowship in the Department of Electrical Engineering and Computer Science.

Tamara Williams, a graduate student in EECS, received a Leadership Award at the 28th annual Martin Luther King, Jr. Celebratory Breakfast, for having devoted herself to racial and cultural interaction in the MIT community.

Pius A. Uzamere II, a sophomore in EECS, won the third annual Dr. Martin Luther King, Jr. Oratory Contest.

The Lemelson-MIT Program awarded its 2002 Student Prize for inventiveness to Andrew Heafitz, a graduate student in Mechanical Engineering. The Lemelson-MIT Student Prize judging panel selected Heafitz, a 32-year-old doctoral candidate in Mechanical Engineering for his ingenuity and remarkable inventiveness. Among Heafitz's notable inventions are a low-cost rocket engine and an aerial surveillance system designed for the US Army.

The Ronald E. McNair Scholarship Award recognizes black undergraduates who have demonstrated strong academic performance and who have made considerable contributions to the minority community. Created by the Black Alumni/ae of MIT in honor of Dr. McNair, who

died in the explosion of the space shuttle Challenger, four of five of this year's award went to engineering students: Nathan A. Fitzgerald Aeronautics and Astronautics, Ebraheem I. Fontaine of Mechanical Engineering, Irfan S. Pirmohamed of Aeronautics and Astronautics, Jeannette D. Stephenson of EECS, and Huanne T. Thomas of Chemical Engineering. The Black Alumni/ae of MIT created the award in honor of Dr. McNair (PhD 1977), who died in the explosion of the space shuttle Challenger.

Paul K. Njoroge, a graduate student in EECS was one of two MIT students among 32 students at universities in the United States to win prestigious Rhodes Scholarships for 2002. Rhodes Scholars are chosen on the basis of intellectual and academic ability, integrity, respect for others, and the ability to lead and to use their talents fully. Njoroge was recognized for demonstrating social conscience, vision, leadership and organizational skills at MIT.

This year, five graduate students in EECS were named Siebel Scholars: Omar Aftab, Luciano Castagnola, Jolie Chang, Eko Lisuwandi, and Edward Tolson. The Siebel Scholars program provides scholarships in recognition of students who have demonstrated academic and leadership excellence in the first year of their graduate studies at the world's leading graduate schools of business and computer science.

Three engineering students received William L. Stewart Jr. Awards, which recognize contributions by an individual student or student organizations to extracurricular activities and events during the preceding year: Jaime E. Devereaux, a senior in Aeronautics and Astronautics, Michael R. Folkert, a graduate student in Nuclear Engineering, and Alvar Saenz Otero, a graduate student in Aeronautics and Astronautics. The awards are given in memory of William L. Stewart Jr., an alumnus and member of the Corporation who showed deep interest in student life at MIT.

Awards to Engineering Staff

This year, the School continued the Rewards and Recognition program it launched last year to recognize the achievements of the School's dedicated staff. In April, the School presented 15 Infinite Mile Awards for 2002 at its second annual school-wide celebration of excellence.

The School presented 12 awards in the category of Excellence. Bronze awards went to Debra R. Blanchard of Mechanical Engineering, Britton M. Bradley of the Lab for Computer Science, Jonathan Griffith of the Leaders for Manufacturing/System Design and Management programs, Michael S. Lewy of the Laboratory for Information and Decision Systems, Eileen Ng Ghavidel of the Laboratory for Information and Decision Systems, and Margaret Udden of Aeronautics and Astronautics.

E. Peggy Garlick of Mechanical Engineering, Kimberly J. Bond Schaefer of the Biological Engineering Division, and Lydia O. Wereminski of EECS received silver awards.

Richard R. Fenner of Mechanical Engineering, Beverly Kozol-Tattlebaum of the Engineering Systems Division, and Deborah Hodges-Pabon of the Microsystems Technology Laboratories received gold awards.

The School honored two recipients with gold awards in the category of Diversity and Community: Marilyn A. Pierce of EECS and Vivian M. Mizuno of the Laboratory for Electromagnetic and Electronic Systems.

The School awarded a bronze Infinite Mile Award in the category of Institutional Bridging to Daniel E. Whitney of Mechanical Engineering and the Engineering Systems Division.

Statistics for 2001–2002

The following statistics provide summary information about students, degrees awarded, and faculty.

Undergraduate Enrollment

- 1,885 students
- 35% women
- 22% underrepresented minorities

Graduate Enrollment

- 2,664 students
- 609 women
- 112 underrepresented minorities

Degrees Awarded

- 667 bachelor's degrees
- 803 master's and MEng degrees
- 239 PhD, ScD, and professional engineering degrees

Faculty

- 228 professors
- 71 associate professors
- 45 assistant professors

Thomas L. Magnanti
Dean, School of Engineering
Institute Professor
Professor of Management Science and Electrical Engineering

More information about the School of Engineering can be found on the web at http://web.mit.edu/engineering/.

Department of Aeronautics and Astronautics

Undergraduate Program

Undergraduate Enrollment over the Last Ten Years

	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02
Sophomore	33	36	36	30	46	40	48	59	68	56
Juniors	60	31	37	31	23	33	37	40	53	69
Seniors	66	66	38	37	29	24	35	37	45	53
Totals	159	133	111	98	98	97	120	136	166	178
% of Women	28%	32%	31%	29%	26%	30%	33%	30%	32%	33%
% of Under. Minorities	12%	23%	19%	16%	18%	22%	15%	12%	21%	22%

Graduate Program

A total of 296 applications were received for the fall 2001 term. Out of these, 144 were admitted and 77 accepted the offer of admission. Enrollment for fall 2001 included 77 SM, 0 EAA, nine doctoral, three MEng degree candidates for a total of 76. There were a total of four minority students (no doctoral and four SM) and 21 women students (three doctoral, 16 SM, and one MEng). For the spring 2002 term we received 29 applications. We admitted 17 and 13 enrolled, including five woman. One minority application was received. Enrollment for spring 2002 included 10 SM, three doctoral, and zero MEng for a total of 13. Total women students numbered five (one doctoral and four SM). There was one minority student (one SM; zero MEng).

Funding	Fall '00/Spring '01
MIT Fellows/Tuition Awards	13
Outside Fellowships Staff Appointments (RAs, Draper Fellows)	2 47
Teaching Assistants and Fellows	11
Engineering Internship Program	0
Other Types of Support	3
(Employer, Foreign, Self)	0
Total	76

Faculty Notes

Raul Radovitzky joined the department as Charles Stark Draper assistant professor, working in the area of multiscale modeling and simulation of the mechanics of advanced materials and in computational solid mechanics. Zoltan Spakovszky joined the faculty as Carl Richard Soderberg assistant professor, and Karen Willcox joined the faculty as Charles Stark Draper assistant professor, both in the fluid mechanics, propulsion and energy conversion division. Zoltan and Karen each spent almost a year in industry (at GE Aircraft Engines and Boeing, respectively) between receiving their PhD and joining the faculty, as part of the department's plan to further enhance the strong contact with the aerospace industry. Oliver De Weck joined the department in the area of engineering systems, with a dual appointment in the Engineering Systems Division. He comes to MIT with five years of professional experience at McDonnell Douglas and SF Aircraft and Systems.

David Darmofal and John-Paul Clarke were promoted to associate professor without tenure effective 1 July 2002. David Miller and Brian Williams received tenure effective 1 July 2002.

Wesley Harris returned from holding the Goldwater Chair at Arizona State University and has been appointed Draper professor. Mark Drela has been appointed Kohler professor in fluid dynamics and Brian Williams has been appointed Finmeccanica career development professor. Carlos Cesnik and Nesbitt Hagood have left the faculty: Cesnik for the University of Michigan; Hagood to work with a startup.

Margaret-Anne Storey, of the University of Victoria, BC, was a visiting associate professor during 2001–2002, working with Nancy Leveson on software engineering. Allen Haggerty, former VP and general manager, Boeing Military Aircraft and Missile Systems Group, was in residence as the Hunsacker professor working with the Lean Aerospace Initiative. He delivered the 2002 Minta Martin Lecture entitled "Lean Engineering has finally come of age (or why we can't ignore 80% of a product's cost anymore)". Dr. Jeffrey Hoffman, a former NASA astronaut (and Harvard astrophysics PhD), has been in residence during the year and will continue his visit, teaching and working with the department on developing plans to use the International Space Station as a testbed for new aerospace technologies.

John Hansman was elected fellow, AIAA. Earll Murman was elected fellow of the Royal Aeronautical Society. Dava Newman received the Aerospace Educator Award for 2001 from Women in Aerospace. Steven Hall was selected as a MacVicar Fellow. Amedeo Odoni received a Lifetime Achievement Award from the Institute for Operations Research and the Management Sciences. Ian Waitz received the the Class of 1960 Innovation in Education Award. As of 1 August, Ian will take up the position of associate department head, succeeding Edward Greitzer.

Research Highlights

Aerospace Computational Design Laboratory

The mission of the Aerospace Computational Design Laboratory (ACDL) (formerly the Fluid Dynamics Research Laboratory) is to improve the design of aerospace systems through the advancement of computational methods and tools that incorporate multidisciplinary analysis and optimization, probabilistic and robust design techniques, and next-generation computational fluid dynamics. The laboratory studies a broad range of topics that focus on the design of aircraft and aircraft engines.

Current research projects include: the development of a "distributed flow simulation environment" capability; aerodynamics of subsonic, transonic, and hypersonic vehicles; aeroelasticity; development of low order aerodynamic models for multidisciplinary analysis; computational approaches to active flow control; the development of tools for aerodynamic analysis and design; distributed visualization; development of distributed fast equation solvers; and development of algorithms for assessing and quantifying numerical uncertainty.

Lean Aerospace Initiative

Current Goals, Objectives, Priorities

The Lean Aerospace Initiative (LAI) is an evolving learning community that brings together key stakeholders from 25 aerospace companies, 15 US government offices and programs, organized labor, and MIT. It is a consortium-guided research program led by the MIT Department of Aeronautics and Astronautics in close collaboration with the Sloan School of Management, and managed under the auspices of the Center for Technology, Policy and Industrial Development (CTPID). LAI also collaborates internationally with LARP (Lean Aerospace Research Program) at Linköping University and the UK LAI.

Transforming an Industry

The Lean Aerospace Initiative (LAI) was born out of practicality and necessity as declining defense procurement budgets collided with rising costs and military industrial overcapacity prompting a new defense acquisition imperative: affordability rather than performance at any cost. The initiative was formally launched in 1993 when leaders from the U.S. Air Force, the Massachusetts Institute of Technology (MIT), labor unions, and defense aerospace businesses forged a trail-blazing partnership to transform the industry, reinvigorate the workplace, and reinvest in America using a philosophy called "lean."

An Evolving Lean Message – An Evolving Lean Community

Lean is about people and processes efficiently delivering value to every stakeholder. This means achieving lean capability at the enterprise level. Creating lean enterprise value goes well beyond figuring out better ways to do the job right—it's also about doing the right job. It means eliminating waste with the goal of creating value, being responsive to change, continually focusing on quality, and enhancing the effectiveness of the entire workforce.

Today, LAI's community extends forward to the customer and reaches back through the supply chain. The consortium now consists of leaders and implementors from major US defense and commercial aerospace companies, suppliers, government agencies, organized labor, and MIT.

Through active partner collaboration, LAI functions as a real world laboratory. Resulting benchmarking data and other findings fuel an ongoing cycle of learning including the application of knowledge, assessment of progress, and continuous improvement. Ultimately this cycle generates new research questions leading to new results, and lasting value. It also provides a foundation for more tangible and meaningful tools and products that enable lean transformation efforts across the enterprise—products such as the Lean Enterprise Model (LEM), the Enterprise Transition To Lean Guide (TTL), and the Lean Enterprise Self-Assessment Tool (LESAT). LAI's research base also continues to fold into policy recommendations.

Accomplishments, Research Results, and Knowledge Products

Through its ongoing Lean Effects on Aerospace Programs (LEAP) exploratory study, LAI has found strong impact from lean occurring over the period of 1992 to 2000, with a large acceleration since 1997 representing as much as: ~60 percent increase in inventory turns; 40+ percent increase in labor productivity (current dollars); and as much as 80 percent reduction in product development cycle time. This research also revealed lean to remain heavily concentrated on factory floor. Basic lean changes still, however, benefit as much as 95 percent of shipped products and impacts 40–80 percent of all manufacturing and procurement processes.

Other recently published research includes findings and recommendations around:

- The internet as an enabler to the lean enterprise
- Framework for comparing performance improvement programs
- Value creation in the product development process
- Fostering innovation across aerospace supplier networks
- Lean thinking in aircraft flight testing
- Valuation techniques for commercial aircraft design
- Manufacturing system design in the defense aerospace industry

- Flexible manufacturing systems and value stream mapping
- Valuation techniques for complex systems

As of May 2002, the LAI student roster totaled 16 MS and PhD candidates including:

8 Aeronautics-Astronautics
4 Technology and Policy
2 Technology and Management
1 Mechanical Engineering
1 Sloan School
1 USAF Research Fellow

Also as of May 2002, LAI had recorded 57 graduated MS and PhD students with:

12 entering government service
10 entering aerospace industry
15 entering consulting industry
18 entering other professions
2 continuing studies at MIT

Lean Transformation Tools and Products

In the past year, LAI has stepped up efforts to help transform the US aerospace enterprise by developing and deploying education programs as well as leadership and transformational tools including:

Lean Learning II Workshop—The race toward lean knowledge accelerated when 74 learners, change agents and implementors from across the aerospace community, gathered for LAI's Lean Learning II workshop in Charlotte, November 6–8, 2001. The second in a series of activity-based professional development forums, this workshop emphasized both people and process, and focused on the organizational behaviors as well as specific tools, such as LAI's LESAT, that enable lean transformation. It also featured an emerging LAI product "The Workbook for Change," a how-to soft skills guide.

"Lean Enterprise Value: Insights from MIT's Lean Aerospace Initiative (LEV)—Published by Palgrave in March 2002, this book outlines the core challenge for industry in the 21st century as the ability to identify and deliver value to every stakeholder and the subsequent requirement of lean capability at the enterprise level. The LEV book demystifies the three levels of enterprise, offers a Value Creation Framework, and concludes with Enterprise Level Lean Principles.

Enterprise Value: The New Lean Horizon—This annual stakeholders conference, held March 26–27, 2002, featured key lessons from "Lean Enterprise Value" and honed in on the larger concepts of what an enterprise is by looking beyond manufacturing successes to the greater opportunities associated with addressing an enterprise as a whole.

Sharing multiple enterprise perspectives were Bob Nelson, corporate vice president business strategy, Northrop Grumman Corporation; Carolyn Corvi, vice president-general manager, Boeing 737 Program; Mike Fortson, director JSF Affordability, Lockheed Martin Aeronautics; and Ellen Plese, Atlas Program Office, Lockheed Martin Astronautics.

"Our experience with lean principles has shown that lean enables the cultural, process, and systems integration required to meet future customer requirements," said Bob Nelson. "Lean also offers a new common denominator."

LAI-Defense Acquisition University (DAU) Strategic Partnership Established—On May 22, 2002, LAI and DAU signed a Memorandum of Understanding to engage in collaborative work in two broad areas: acquisition research and curriculum development. Work has already started on development of a web-based introductory learning module of basic lean concepts suitable for government, industry, or academic applications. Future work would include collaboration on the inclusion of lean enterprise perspectives in the DAU capstone Program Manager's Course.

Lean Enterprise Value Executive Short Course—On June 19–21, 2002, LAI presented its first Executive Short Course to 25 leaders and implementers from aerospace. Designed and built around an integrated enterprise simulation game, this class encouraged experiential learning and immediately application of lecture materials. Content was derived from the LEV book beginning with an overview of lean fundamentals and culminating with a broad perspective of the integrated operations between the enterprise functions and their impact on achieving a lean enterprise transformation.

Moving Forward

Undeniably, LAI has taken root, grown, and flourished as a successful new model of industry, government, labor, and university partnership. But perhaps more importantly, LAI represents a true learning community with the ability to leverage multiple perspectives for longer-term solutions. Through this community, LAI is able to open and sustain knowledge sharing, create a common vocabulary, infuse new ideas into the industry, and enhance communication among all stakeholders. This accelerates lean transformation efforts by bridging sectors and cultures as well as organizational functions, layers, and competing interests. It also creates a system to rapidly diffuse best practices throughout the enterprise. Now LAI is poised to do for the rest of the enterprise what it did for manufacturing.

As LAI begins in next phase, the Enterprise Value Phase, in September 2002, the consortium will work to shift mindsets away from "silos" and into the enterprise, and to broaden LAI impact up, down, and across value streams.

LAI itself will model best practices by focusing on integrated goals, deliverables, and products that meet the needs of multiple stakeholders. As part of this vision, LAI is introducing the LAI Educational Network (LEN), a cadre of other colleges and universities who can help to foster lean thinking through education while expanding curriculum development and delivery.

Lean Sustainment Initiative

Established in 1997, LSI's mission is to enable a fundamental transformation of the US commercial and military maintenance, repair, and overhaul (MRO) industries into cost-effective, quality-driven, timely, and responsive support enterprises. As a joint academic-military-industry consortium LSI develops research-based recommendations for systemic change followed by the implementation of military-industry pilots to demonstrate the impact of the recommendations on the MRO effectiveness of the enterprises.

Two aerospace industry leaders have joined LSI, a development that signals firm industry commitment to streamlining the US Air Force's $5.4 billion dollar MRO operations. The Boeing Commercial Airplane Company and the Chromalloy Gas Turbine Corporation joined LSI in late 2001. In joining LSI, these industry leaders reinforce existing efforts to apply lean principles, processes, and practices to the sustainment operations, business processes, and enterprise integration that keep the backbone of America's air defense system—legacy aircraft like B-52s, C-5s, F-15s, F-16s, KC-135s—in the air. Boosting sustainment efficiency could increase the percent of US air war fighters that can go into immediate action within existing fiscal constraints about 75 percent.

During 2001–2002 LSI completed three studies: the impact of policy on the availability of materials and parts; identification of barriers preventing the flow of high quality data input to forecasting tools; identification and quantification of goals, objectives, and metrics that drive behavior and performance at the flight line. Based on the results of these studies, recommendations for implementation pilots have been developed and presented by MIT for LSI stakeholder review.

LSI members delivered invited presentations at the Society of Automotive Engineers Aerospace Congress and Exhibition, September 10–14, 2001, Seattle, Washington, and the Caribbean Academy of Sciences 13th annual meeting and conference, June 1–4, 2002, Mona, Jamaica.

In addition, LSI produced several master's theses, white papers, and technical briefings.

Next year's plans include: further expansion of stakeholder base to include international corporations and more national corporations; continue the development of graduate and executive level sustainment courses with analytical framework and case studies; initiation of implementation pilots.

Man Vehicle Laboratory

The Man Vehicle Laboratory continues to be at the forefront of research in aerospace physiology, human factors, and cognitive engineering, supported by NASA, the National Space Biomedical Research Institute, DOT, FAA and industry.

In the space research domain, Man Vehicle Laboratory continues a multi-year effort to build the suite of spaceflight-qualified virtual reality display hardware for the International Space Station (ISS) Human Research Facility, with the assistance of professional engineering staff from MIT's Center for Space Research. The hardware supports "VOILA" (Visuomotor and Orientation Investigations in Long Duration Astronauts), a family of nine flight experiments developed under MVL director Dr. Charles Oman's leadership by a US-French-Italian-Canadian science team, to be conducted on the ISS in 2004-2005.

Professor Dava Newman's new microgravity disturbance experiment for ISS, "MICRO-G" is approved and entering definition stage this fall. Final reports and journal articles appeared for Professor Newman's Enhanced Dynamics Load Sensor Experiment, which flew on the Russian Mir space station, and for Dr Oman's STS-90/ Neurolab experiments on human visual orientation. Both undergraduate and graduate students participated in several parabolic flight experiments supporting the VOILA and MICRO-G.

In the aeronautical domain, Dr. Oman's experiments on pilot performance using vertical navigation profile displays appeared in journal form. He participated in writing the SAE standards for such displays, and Boeing is introducing the first airliner version this year. A new program of research on assessment of pilot attention and eye movement patterns using hidden markov models is underway in collaboration with DOT Volpe Center colleagues, as part of a research program on airliner head up display certification standards. Dr. Oman and Dr. Alan Natapoff continue to collaborate with Professor James Kuchar on experiments on time-critical decision making in a military aircraft route replanning context. Preliminary results were presented.

In the educational domain, Professor Newman continued to develop new curricula in the space biomedical engineering area, supported by the National Space Biomedical Research Institute. She also leads the department's active learning tools development project, sponsored by Microsoft's Project I-Campus. Supporting these programs, Drs. Oman and Young developed a new alternate year HST graduate subject on spatial orientation and vestibular function. As part of the department's CDIO effort to increase awareness of aerospace system operational issues, Dr. Oman organized

a faculty trip to United Airlines Training Center for Boeing 737 familiarization training. Over IAP 2002, he and Brian Nield of Boeing held a four-day, 20-hour Boeing 767 systems and automation course, utilizing the Project I-Campus flight simulation lab facilities, and Boeing-supplied computer based training software. Several pilot alumni also participated as instructors. During the spring semester, graduate students from MVL, SERL, and ICAT participated in a new cognitive human factors engineering seminar, supervised by Dr. Oman and this group founded a student chapter of the Human Factors and Ergonomics Society.

This year Professor Laurence Young retired as director of NASA's National Space Biomedical Research Institute (NSBRI), but continues in a leadership role as special advisor to the director. Dr. Oman continues to serve on the Space Station Utilization Advisory Subcommittee (SSUAS) of the NASA Advisory council, and leads all NSBRI programs in the Neurovestibular discipline (42 investigators from 21 institutions) Professor Newman received tenure, and is spending part of a sabbatical year aboard her 48-foot sailboat circumnavigating the world, and conducting a collaborative educational experiment "Galatea World Odyssey", which introduces students to history, geography, science, and techonology by means of local lectures, visits aboard, and an expedition web site.

Software Engineering Research Laboratory

Software Engineering Research Laboratory (SERL) is relatively new to the department, being part of the recent expansion and redirection of the department focus. It was started four years ago when Professor Nancy Leveson joined the faculty. This year Professor Kristina Lundqvist and Professor Charles Coleman have joined SERL. Currently, SERL has 14 graduate students, two undergraduates, two postdocs, a visitor from NASDA (the Japanese Space Agency) and a visiting professor from Canada.

Research in SERL focuses on topics related to the design of complex systems having software components. The development of software in these systems cannot be separated from system engineering activities and much of the research in the lab would more properly fit into the category of systems engineering than software engineering. SERL research is cross-disciplinary and spans aeronautics and astronautics, computer science, human factors and cognitive engineering, system safety engineering, and other disciplines and applications using computers for control (such as transportation and medical devices). SERL researcher are working with Eurocontrol, NASA, Raytheon, Ford, and others on such diverse applications as air traffic management, aircraft avionics and flight management systems, autonomous vehicles, robots, the International Space Station, and interplanetary spacecraft. Research topics include model-based system and software engineering, system safety engineering, system and software requirements specification and analysis, and design of human-computer interaction (cognitive engineering).

Space Grant Consortium

The Massachusetts Space Grant Consortium (MASGC) added two affiliate members this year and now includes MIT (lead), Tufts University, Wellesley College, Harvard University, Boston University, University of Massachusetts, Worcester Polytechnic Institute, Marine Biological Laboratory, Five College Astronomy Department, Northeastern University, Williams College, Holy Cross University, Boston Museum of Science, the Christa McCaullif Center/Framingham State College, and the Charles Stark Draper Laboratory.

MASGC continues to support a wide variety of programs aimed at education/public outreach and aerospace workforce development. MASGC contributes to the education of pre-college teachers in space science and engineering through summer workshops run by the Wright Center at Tufts. MASGC continues to support undergraduate research through the MIT Undergraduate Research Opportunities Program and similar programs at affiliate institutions. It also provided graduate fellowships last year for three students. MASGC supported several students at the summer Space Academies at NASA's Goddard and Ames centers. It increased the number of companies involved in placing students for summer employment in the aerospace industry and organized a summer jobs fair in conjunction with MIT's career fair.

Last November, in cooperation with the Boston Museum of Science, MASCG hosted the annual "New England Space Day", inviting students supported by MASGC and other New England Space Grant Consortia to present the results of their research to an assembly of Boston area high school students. The students then heard a lecture by Dr. Janice Voss, NASA astronaut, on synthetic aperture radar mapping of the Earth from space. During the spring semester at MIT, MASGC sponsored a popular undergraduate seminar on "Modern Space Science and Engineering", with guest speakers from our industrial and academic affiliates. The annual Space Grant public lecture this year was given by Professor Jeffrey Hoffman, an Aero/Astro faculty member and a former NASA astronaut, on "Exploring Space with Humans and Robots". Professor Hoffman joined MASGC this year as associate director and is currently serving as acting director.

Space Systems Laboratory

Model-based Embedded and Robotic Systems Group

A new generation of sensor rich, massively distributed, embedded systems are being developed that have the

potential for profound social, environmental, and economic change. The objective of the model-based embedded and robotic systems group (MERS) is to revolutionize the way in which we create and control these new artifacts.

MERS was created three years ago and includes roughly twenty students, postdocs, visitors, faculty and staff. The group's accomplishments this year included the completion of five master's theses, a bachelor's thesis, five journal and conference papers, the creation of a cooperative rover testbed, and several demonstrations of model-based autonomy capabilities, summarized below.

Research in Model-based Autonomy

The challenge of space exploration has dramatically shifted, from simple fly-bys to micro-rovers that can alight upon several asteroids, collect the most interesting geological samples, and return with their findings. This challenge will not be answered through billion dollar missions with 100 member ground teams, but through innovation. Future space exploration will be enabled in significant part by inexpensive, fire and forget space explorers that are self-reliant and capable of handling unexpected situations; they must balance curiosity with caution.

Self-reliance of this sort can only be achieved through an explicit understanding of mission goals and the ability to reason from a model of how the explorer and its environment can support or circumvent these goals. Robustness of this sort can only be achieved by careful coordination of the complex network of sensors and actuators within a spacecraft. Given the complexity of current (and future) spacecraft, such fine-tuned coordination is ordinarily a nearly-impossible task, both conceptually and as a software engineering undertaking. Such coordination is also essential to creating and operating future networked embedded systems, such as earth orbiting, remote sensor networks. Similar levels of robustness and ease of use are equally relevant in more down to earth contexts, within complex embedded systems of the sort found in environmental control of large buildings.

Our research confronts these challenges by introducing a new automated reasoning paradigm called *model-based autonomy*. We envision model-based explorers that are programmed rapidly and simply by specifying strategic guidance in the form of a few high-level control behaviors, called *model-based programs*. These control programs, along with a commonsense model of its hardware and its environment, enable an explorer to control and monitor its hidden state according to the strategic guidance. To respond correctly in novel, time-critical situations, our explorers use their onboard models to perform extensive commonsense reasoning within the reactive control loop, something that conventional AI wisdom had suggested was not feasible.

Our work on model-based autonomy this year resulted in a range of increasingly capable model-based autonomous systems, named Titan, Kirk and Moriarty. Each system has required significant advances in real-time reasoning along three fronts: model-based diagnosis and estimation, model-based planning and execution, and deductive, commonsense reasoning. Theses capabilities were applied to scenarios for three space missions (the Air Force's TechSat21, and NASA's ST-7 and Messenger Missions), Mars rovers, a Martian habitat and cooperative automobiles.

Titan: Model-based Programming and Execution

Model-based autonomy has the potential to make everyday embedded systems more robust, including automobiles, air vehicles and copiers. The challenge is to make it simple enough for any programmer to use and fast enough that they are willing to use it. We are creating increasingly fast and powerful model-based executives, which are made easy to use through the metaphor of model-based programming.

This year we completed the development of the first release of our Reactive Model-based Programming Language (RMPL). RMPL simplifies embedded programming by allowing the programmer to read and set the evolution of state variables hidden within the hardware. For example, an RMPL program might state, "produce 10.3 seconds of 35 percent thrust," rather than specifying the details of actuating and sensing the hardware (e.g., "signal controller 1 to open valve 12," and "check pressure and acceleration to confirm that valve 12 is open").

To execute RMPL programs we completed Titan, an execution system that automatically turns RMPL programs into hardware control actions that generate and monitor the desired state evolution. Titan is safe in the sense that it avoids potentially damaging, irreversible actions. Titan is fast; it plans and diagnoses quickly by shifting most reasoning to compile time, which allows it to generate each action in roughly constant time. RMPL is opening the software engineering community to the potential of dynamic languages that reason from models. During this year Titan was demonstrated on scenarios for the Air Force TechSat21 mission, and NASA's Mercury Messenger and ST-7 missions. Our future research will explore the role of compile-time analysis of RMPL programs to achieve high assurance and responsiveness.

Kirk: Model-based Programming of Cooperative Robotic Networks

Networks of unmanned air, space and land vehicles are being created that will perform elaborate missions in uncertain environments. Autonomy is key; the potential interactions between vehicles are too complex for programmers to predefine manually and the required response time is too fast for operators to handle on the fly. This is similar to the preceding challenge of coordinating a

system's internal network of devices, except that the devices are far more complex, highly autonomous and agile. Kirk extends model-based programming and execution to the coordination of these agile, cooperative systems.

Kirk demonstrates that model-based programming languages can manage a rich set of interactions automatically—planning, scheduling, state estimation, and control, and that representations for describing the semantics of programs can be used to reason about complex, cooperative behaviors. Kirk was selected this year for the first phase of the NASA ST-7 autonomy validation mission. This research is enabling a new paradigm for cooperative air vehicles and Mars exploration. The concept of a cooperative Mars mission, including overhead blimps and distributed sensing networks, was demonstrated to the NASA Mars program within our multi-rover test bed. Our future research will incorporate distributed reasoning, agile vehicle path planning and intercommunication into the overall coordination process.

Moriarty: Hybrid Model-based Adaptive Systems

On September 23rd 1999, the Mars Climate Orbiter burned up in the Martian atmosphere. Extensive investigation found that a units error in a table of small forces introduced an indiscernible fault that over time caused mission failure. The subsequent Mars Polar Lander failure proved equally subtle. This thrust tackles the challenge of detecting and diagnosing failures during their onset, when the earliest symptoms may be hidden within the noise.

We are developing a model-based adaptive reasoning system, called Moriarty, which detects the onset of failure that are extremely subtle, and automatically learns the hybrid discrete/continuous models that are needed to perform these diagnoses.

Moriarty is being applied to advanced life support at Johnson Space Center. This year we published several papers on a method, called Hybrid Mode Estimation, that is able to detect the onset of subtle, multiple point failures. In addition we completed a thesis on automated learning of hybrid discrete/continuous models. Our future research will incorporate Moriarty within a hybrid executive that addresses the challenge of entry, descent and landing, highlighted by the Mars Polar Lander failure.

Technology Laboratory for Advanced Composites

The most significant events during the past year were the arrival of Professor Raul Radovitzky from the California Institute of Technology in September 2001 and the departure of Professor Carlos Cesnik to the University of Michigan in August 2001. Since January 2002 Dr. Kim Blair has been associated with the lab as a research scientist. The personnel of TELAC during AY2002 included three faculty members (Lagace, Radovitzky, and Spearing), one research scientist, one engineering specialist, four post doctoral researchers, fifteen graduate students, sixteen UROPers, and twelve undergraduate students in the undergraduate projects class (16.621/2) who performed their research projects in the laboratory. Professor Constantinos Soutis was a visitor in the lab from Imperial College London, from July 2001 until August 2002, and Mr. Mats Brickman was visiting from Saab Aerospace from January 2002 until April 2002 . Four students finished their master's theses in the laboratory during 2001/2 and three doctorates were completed during this period. Approximately 47 research papers and reports were published during the year by laboratory personnel.

With the arrival of Professor Radovitzky the research activities have broadened significantly. New activities include simulation of the effective mechanical response of polycrystals with special emphasis on incorporating mechanisms of deformation and failure taking place at the microstructural scale, while at the same time having a decisive effect on the macroscopic behavior. Also underway is the development a numerical approach for the design of nanomechanical biodetectorsas part of a collaborative effort with the California Institute of Technology to realize the goal of developing single-cell biodetectors through the novel use of bio-functionalized nanoelectromechanical systems (BioNEMS). This research will play an important role in designing a miniature, portable, and robust BioNEMS sensor.

Professor Radovitky is also leading an effort to simulate blast-structure interactions with the goal of developing an end-to-end simulation capability to represent complex weapon-target interaction applications. Some of the targeted DOD challenging application areas include penetration into deeply buried structures, force protection applications against terrorist threats, optimized design approaches for improving lethality of weapons and decreasing vulnerability of structures, and non-conventional weapon-target interaction.

Continuing projects include the accelerated insertion of materials (composites), actively conformable aerodynamic control surfaces, highly flexible composite wings, fatigue/ damage tolerance for composite structures, fatigue of Ti/Gr hybrid laminates, materials, structures and package design for high power density microsystems, metal-composite adhesive joining, piezo-induced fatigue of adhesive joints, structural design of a howitzer launched aerial vehicle and structural health monitoring for composites, including the use of ferromagnetic shape memory alloys.

The laboratory continues to have extensive collaborations with industry, including Boeing, Draper Laboratory, Rockwell Scientific, and Sikorsky , other academic institutions, including the California Institute of Technology, Cambridge University, Clark Atlanta

University, Hirosaki University, Imperial College, University of Michigan, and Stanford University. Within MIT strong collaborations exist with the Gas Turbine Laboratory, Fluid Dynamics Research Laboratory and the Microsystems Technology Laboratory and groups in Chemical Engineering, Materials Science and Engineering, and Mechanical Engineering.

Department Awards

Undergraduate Awards

The Yngve Rausten Award was presented to Namiko Yamamoto, a sophomore from Tokyo, Japan, for "outstanding academic achievement in each of the components of unified engineering, for consistently and successfully bridging the two cultures of modern Japan and MIT, and for extending genuine friendship and outreach to the unified engineering community."

The Andrew Morsa Memorial Award was presented to Christopher Rakowski, a senior from North Arlington, NJ, for "outstanding ingenuity and initiative in the application of computers to the ARGOS imaging satellite system test bed."

The David J. Shapiro Memorial Award was given to Ryan K. Owen, a junior from Great Falls, MT, to "design, build, and assess a GPS-based take-off performance estimator."

The Thomas B. Sheridan Award was presented to Jaime Devereaux, a senior from Barrington Hills, IL, and Margarita Marinova, a junior from Toronto, Ontario, Canada, for an "experimental study of the impact of cognitive distraction on driving while using a cellular phone."

The Leaders for Manufacturing Prize was awarded to Emily M. Craparo, a senior from Destin, FL, and Benjamin T. Ingram, a senior from Landale, PA, for "innovation in developing a rapid, cost-effective, and robust construction method for a micro-sized ornithopter wing." The LFM prize was also presented to Mark A. Monroe, a senior and first-year graduate student from Middletown, RI, and Nathan A. Fitzgerald, a senior from Hyannis, MA, for "demonstrating excellence in modern manufacturing processes in the fabrication and assembly of a micro gas turbine engine ejector-mixer testing apparatus."

The United Technologies, Corp. Award was given to Aleksandra Mozdzanowska, a senior from Drexel Hill, PA, and Paul H. Nicholson, a senior from Amherst, MA, for their project on the "parametric study of the effect of geometric variations on flow fields in combustors." The United Technologies award was also presented to David M. Bennett, a senior from North Hampton, NH, and Todd A. Oliver, a senior from Austin, TX, for their project on the "wing-grid: a new approach to reducing induced drag project."

The James Means Memorial Award For Excellence in Space Systems Engineering was presented to Kay U. Sullivan, a first-year graduate student from Huntsville, AL, for her "superior work in providing keen and insightful analyses to develop optimum system architectures for a Mars sample return mission." This award was also presented to Marcus J. Dos Santos, a senior from Winfield, AL, for the "design and construction of the structure of the ARGOS imaging satellite system test bed."

The James Means Memorial Award for Excellence in Flight Vehicle Engineering was presented to Roland E. Burton , an exchange student from Altincham, Wales, for the "design and analysis of the flight propulsion and power system for an unmanned lighter-than-air surveillance vehicle."

The Admiral De Florez Award for Original Thinking or Ingenuity was presented to Roland E. Burton and Krzysztof J. Fidkowski , a junior from Macungie, PA, for "demonstrating original thinking in the conception and definition of their project 'A Variable Rear Wing Control System for Road Vehicles', and for showing enormous initiative leading to an impressive demonstration of an actively controlled wing."

The De Florez award was also presented to Marianne H. Okal from Evanston, IL, for "pursuing her original idea of designing a device that can detect excessive damage to climbing carabiners not detectable by visual examination."

The Henry Web Salisbury Award was presented to Benjamin T. Ingram, for "superior academic achievement in every category of the undergraduate degree program of the Department of Aeronautics And Astronautics and for demonstrated excellence in theory, design, and implementation covering several components of aeronautics and astronautics."

Edward F. Crawley
Department Head
Professor of Aeronautics and Astronautics
Professor of Engineering Systems

More information can be found on the Department of Aeronautics and Astronautics web site at http://web.mit.edu/aeroastro/.

Department of Chemical Engineering

In the academic year 2001–2002, the Department of Chemical Engineering at MIT maintained and exceeded its usual high productivity and visibility in teaching and research. For the thirteenth year in a row, *US News and World Report* awarded the department the number one ranking in chemical engineering. The department also had a tremendous year fiscally, with research dollar volume topping $22 million. This represents a 16.33 percent increase compared to last year's figure.

During the academic year, 33 doctoral degrees (PhD and ScD) were awarded, along with 39 SM and/or master's-level degrees, totalling 72 advanced degrees conferred. Eighty-two SB degrees were conferred as of June 2002, with 66 percent being awarded to women.

The department's undergraduate enrollment stands at 197 students. A $3.4 million renovation of the entire sub-basement of Building 66 created a state-of-the-art teaching laboratory, thanks in large part to the generous donations of Gordon Cain and Edwin G. Roos '44. The inaugural use was for the spring 2002 semester senior capstone laboratory subject, 10.26. This coming year, undergraduates will receive additional support from the newly renamed and expanded Student Services Office. Formerly this office focused only on graduate students.

The graduate student enrollment is stable at 248 students, with 210 in the doctoral program and 38 master's-level degree candidates, most of whom are students in the David H. Koch School of Chemical Engineering Practice. The graduate programs include 88 foreign, 68 female, and 37 self-identified minority students, of which 24 are Asian Americans. An additional four students from the University of Cambridge, in the United Kingdom, participated in the Practice School Program as part of the Cambridge-MIT Institute. This year, we received 339 applications for our doctoral program and offered admission to 80 individuals; of the 80, 56 will be matriculating in the fall term of 2002.

We are very pleased to announce that Professor Linda G. Griffith was promoted from associate professor with tenure to full professor of chemical and biological engineering, effective July 1, 2002.

With equal delight, we also announce the granting of tenure to associate professor Paula T. Hammond, also effective July 1, 2002. Professor Hammond, along with Professor Gast, played a pivotal role in garnering for MIT a US Army contract to set up the Institute for Soldier Nanotechnologies (ISN), a $50-million, five-year project to develop lightweight molecular materials which can be used to create self-healing and protective gear for soldiers to shield them from weapons of war that are chemical or biological in nature. Professor Hammond is a pioneer in that she is the first woman of African American descent to achieve tenure in the School of Engineering at MIT.

The faculty have once again proven themselves leaders in their fields and we are especially proud to note the following achievements. Professor Robert S. Langer was awarded the 2002 Charles Stark Draper Prize, the highest honor conferred by the National Academy of Engineering, which carries with it an award of $500,000 intended to increase public understanding of the contributions of engineers, particularly in technology, to the welfare and freedom of humanity. Professor Langer is also credited for developing biocompatible polymer technologies that control the release of medicine over time (anywhere from weeks to years) and his contributions to science have significantly advanced the controlled drug delivery industry—a $20 billion industry in the United States alone. Professor Langer is also the 2002 recipient of the Othmer Gold Medal awarded by the Chemical Heritage Foundation. The very same award was first granted to an alumnus of the department, and the namesake of the department's main building—Ralph Landau.

Professor Klavs F. Jensen was elected into the National Academy of Engineering for his fundamental contributions to multi-scale chemical reaction engineering with important applications in microelectronic materials processing and microreactor technology.

The 2002 Merck Award in metabolic engineering was awarded to Professor Gregory Stephanopoulos, and the head of the department, Professor Robert C. Armstrong, received the 2002 Distinguished Service Citation Award from the University of Wisconsin at Madison.

New Initiatives

Molecular Engineering of Biological and Chemical Systems

The Molecular Engineering of Biological and Chemical Systems (MEBCS) program was successfully initiated in 2001 as one of the five graduate programs under the Singapore-MIT Alliance, a joint educational and research enterprise between MIT, the National University of Singapore (NUS) and the Nanyang Technological University, also in Singapore. Chaired by Professor Jackie Ying of MIT and Professor Miranda Yap of NUS, the MEBCS program offers two innovative courses of study that integrate a molecular-level understanding of biological and chemical phenomena with advances in process engineering for the life science and fine chemical industries. It involves 16 faculty fellows from MIT and Singapore, who have jointly developed eight new subjects with advanced distance education technologies, two of which have been cross-listed at MIT. The program currently has an enrollment of 45 SM/PhD students, who were selected in 2002 from an excellent pool of 250 applicants from Asia and Australia. The SM program is an intense one-year course that includes two six-week industrial

immersion projects at international pharmaceutical and fine chemical companies. The PhD program involves advanced coursework and independent research jointly supervised by MIT and Singapore faculty on structured fluids, surface functionalization, microstructure tailoring and materials design in relation to fine chemicals and pharmaceuticals synthesis; as well as on molecular and cellular aspects of biotechnology, genomics, bioinformatics, proteomics, and drug design and delivery that serve as bases for advanced bioengineering. SM and PhD students spend at least one month and one semester, respectively, at MIT for coursework and research interactions.

Deshpande Center for Technological Innovation

Thanks to a generous $20 million gift from Jaishree Deshpande and Desh Deshpande, co-founder of Sycamore Networks, the MIT School of Engineering has established the Deshpande Center for Technological Innovation. Professor Charles L. Cooney, in the Department of Chemical Engineering, has been named center director.

The mission of the Deshpande Center is to focus on support of leading-edge research on new and emerging technologies in a manner that will enable and increase interactions between MIT, individual entrepreneurs, innovative companies, and the venture capital community. Thus, we seek to improve on and broaden skills already incorporated into the Institute's culture.

To achieve this mission, the Deshpande Center will focus on the following objectives:

- to identify and support early stage enabling science and technology
- to catalyze the transfer of technology to innovative companies
- to bring students into more intimate contact with the entrepreneurial process
- to enhance innovative companies, especially in the New England area

The Deshpande Center has formulated a grants program to provide funding to permit faculty and their students to pursue new avenues of research on novel technologies. We anticipate that some of the emerging technology funded through the center will lead to intellectual property that can accelerate the incorporation of the technology into new or existing innovative companies.

The Deshpande Center Grant Program includes two types of funding. These are the ignition grants and innovation program grants for support of research at MIT in all areas of technology. In this first year, the center has available up to $1 million in grants. The scope of the grant program will increase over time, providing a minimum of approximately $15 million in research funding over the next five years.

The ignition grants are meant to provide MIT School of Engineering faculty with funding that will allow them, with students, postdoctoral research associates, and staff, to explore new ideas and new directions that, if successful, will enable them to do something that could not be done before. Funding is targeted at projects that focus on novel, enabling, and potentially useful ideas and concepts in all areas of technology. These grants will typically be on the order of $50,000 and might lead only to exploratory experiments and establishing proof of concept, which could be suitable for follow-on funding with an innovation program grant.

The innovation program grants will fund work on concepts whose technical feasibility has been established; there might already be the basis of some intellectual property but further demonstration of success or broadening of application is required. It is expected that these programs will have well-defined research plans with identifiable milestones and deliverables. It is likely that one or more innovative companies might have been identified as targets for the use of the results for this work and that during the course of the program collaborations might be established. Company collaborations are likely to include licensing of relevant MIT intellectual property. These awards are expected to be up to $250,000 per year.

Undergraduate Education

The department undergraduate enrollment stands at 197 students, with the sophomore class being somewhat smaller than in recent years. Preliminary figures for next year's (2002–2003) sophomore class show a modest increase over this year. The percentage of women in the department now stands at 60. While enrollment is down a bit, student quality remains excellent. Implementation of the undergraduate curriculum revision began with the new introductory subject, 10.10 Introduction to Chemical Engineering, offered for the first time in the spring term of 2001–2002. Both students and the teaching faculty were very pleased with the results, and the subject will subsequently be offered each term. We also began to use

Undergraduate Enrollment over the Last Nine Years

Class Level	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02
Sophomores	115	108	118	87	97	88	71	67	47
Juniors	90	104	101	121	90	90	85	76	66
Seniors	84	100	103	110	130	94	103	89	84
Total	289	312	322	318	317	272	259	232	197

our newly renovated undergraduate laboratory space in the sub-basement of Building 66; it is a wonderful addition to the department's teaching resources. Employment opportunities remain strong across the variety of industries that employ chemical engineers.

Bradley D. Olsen was awarded a prestigious Barry M. Goldwater Scholarship, the only chemical engineering student in the nation to be so honored this year. At the Institute level, Selam Daniel was awarded the Priscilla King Gray Award for public service. Our female athletes were also honored. The American Institute of Chemical Engineers (AIChE) student chapter president, Princess Imoukhuede, a weight thrower, won the Betsy Schumacher Award for excellence in athletic competition, and Michelle Verticchio, a standout in field and ice hockey, took the Malcolm G. Kispert Award for female scholar/athlete of the year.

Graduate Education

Completing their first year of additional responsibilities are Professor Daniel Blankschtein as graduate officer, and Professor K. Dane Wittrup as the head of the Graduate Admissions Committee. Because of their efforts in coordination with the faculty advisors of the department, 100 percent of the past year's rising class passed both the written and oral qualifying examinations and thus have been promoted to candidacy for the PhD/ScD. The incoming graduate class is of similar high caliber, entering with an average undergraduate GPA of 4.87/5.00 and standing at the 93d percentile of the Graduate Record Examinations.

The renovation of the second floor of Building 66 is expected to be completed before the beginning of the fall term of 2002 and will vastly improve the quality of office spaces set aside for graduate students and enable them to exchange ideas more effectively with each other.

Faculty Notes

Professor Robert C. Armstrong continued as head of the Department of Chemical Engineering during the academic year 2001-2002. In November 2001 he received the Distinguished Service Citation Award from the College of Engineering at the University of Wisconsin, Madison. He was elected as second vice chair of the governing board of the Council for Chemical Research; he will chair this organization in 2005. He currently serves on the external advisory boards and/or visiting committees of the respective departments of chemical engineering at the Georgia Institute of Technology, Northwestern and Texas A&M universities, the University of Michigan at Ann Arbor and University of Wisconsin at Madison, and the Virginia Polytechnic Institute.

Professor Paul I. Barton gave invited papers at the Fifth Society for Industrial and Applied Mathematics (SIAM) Conference on Control and Its Applications in San Diego, California; the International Conference on Scientific Computation and Differential Equations in Vancouver, British Columbia, Canada; the Sensitivity Analysis Workshop 2001 at the Lawrence Livermore National Laboratory in California; and the Seventh SIAM Conference on Optimization in Toronto, Ontario, Canada. He gave an invited lecture at Lehigh University in Bethlehem, Pennsylvania. He was elected a director of the American Institute of Chemical Engineers Computing and Systems Technology Division, continued to serve on the editorial board of *Chemical Engineering and Processing*, and organized a mini symposium at the International Conference on Scientific Computation and Differential Equations in Vancouver, British Columbia, Canada.

Professor E. Daniel Blankschtein was a keynote speaker at the 76th American Chemical Society Colloid and Surface Science Symposium in Ann Arbor, Michigan and also chaired a session on "Nanoscale Organization via Self-Assembly in Non-Aqueous Media" at the symposium. He was also guest editor of the section on "Thermodynamics and Theoretical Aspects of Colloid Science" for the journal *Current Opinion in Colloid and Interface Science*. He continues to serve on the editorial boards of *Current Opinion in Colloid and Interface Science* and Marcel Dekker's *Surfactant Science Series*. Professor Blankschtein received the Outstanding Faculty Award from the graduate students in the Department of Chemical Engineering, and continues to serve as graduate officer in the department.

Professor Howard Brenner received the 2001 Fluid Dynamics Prize of the Division of Fluid Dynamics of the American Physical Society. He served as a member of the Chemical Engineering Peer Review Committee of the National Academy of Engineering, and was chosen to serve for the period 2002–2005 as a member of the Membership Committee of that organization. During the year, he presented or co-presented invited seminars and lectures at the State University of New York at Buffalo, the annual meeting of the Division of Fluid Dynamic of the American Physical Society, including delivering the Fluid Dynamics Prize lecture, the Annual American Institute of Chemical Engineers Meeting, the Society of

Graduate Enrollment over the Last Nine Years

Degree Level	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02
Master's	62	64	56	64	51	59	54	40	38
Doctoral	147	166	169	162	167	140	145	166	166
Total	209	230	225	226	218	199	199	206	204

Rheology, the University of Florida Engineering Research Center for Particle Science and Technology, the Division of Engineering and Applied Science at Harvard University, and the International Workshop on Particles and Polymers Near Interfaces in the Netherlands.

Professor Robert A. Brown continued serving as provost at MIT, a position he has held since 1998. He also continued as executive editor of the *Journal of Chemical Engineering Science* and as a member of the National Research Council decadal study on "Frontiers in Chemistry and Chemical Engineering." Among other forms of service, Professor Brown continued to serve on the International Academic Advisory Panel to the government of Singapore and as director of the DuPont-MIT Alliance at MIT. He was a plenary speaker at the World Congress on Chemical Engineering in Melbourne, Australia, in October 2001 and at the American Institute of Architects' Conference on Architecture and Education in Boston, Massachusetts, in April 2002. Professor Brown also delivered the Lavoisier Lecture at E. I. DuPont de Nemours and Company in 2001.

Professor Robert E. Cohen continued as chair of the steering committee of the PhD in Chemical Engineering Practice (PhDCEP), a doctoral program now in its third year of operation. Eleven students are currently enrolled. He also continues to co-direct, with Professor Douglas Lauffenburger, the operations of the DuPont-MIT Alliance, a $35 million/five-year education and research initiative in the area of bio-based materials. Professor Cohen is a member of the external advisory committee of the Department of Chemical Engineering at Columbia University. He continues to serve as a member of the board of directors of the William and Mary Greve Foundation in New York. He is also a director of Mattek Corporation, a surface science/tissue engineering company he co-founded in 1985 with a former colleague, professor emeritus Raymond F. Baddour. Professor Cohen's 12-student research group generates new knowledge, publications, and patents in the area of polymer science and technology. In the past year papers were presented at the meetings of the American Institute of Chemical Engineers, American Chemical Society, and the Materials Research Society, and invited lectures were delivered at the University of Minnesota, the University of Massachusetts, and Columbia University. Professor Cohen's teaching responsibilities include 10.568 Polymer Physical Chemistry, a popular graduate elective in chemical engineering and a required core subject in the curriculum of the interdepartmental Program in Polymer Science and Technology. He developed and delivered a new module for the undergraduate subject 10.491 Integrated Chemical Engineering (ICE). The new ICE module introduces students to concepts of product design and structure/property relationships in the context of polymeric gas separation membranes.

Professor Charles L. Cooney stepped down from the position of executive officer of the department on June 30, 2001, and, after finishing coordination of the American Board of Engineering and Technology review for the department in September 2001, left for a year-long sabbatical at the University of Cambridge in the United Kingdom in the Chemical Engineering Department. He continues on the board of the MIT Community Services Fund. He is co-director of the Consortium for Advanced Manufacturing of Pharmaceuticals, an industry consortium jointly run with Purdue University to support research on pharmaceutical manufacturing and continues as co-director of the Program on the Pharmaceutical Industry, a joint program of the schools of Engineering, Science, Humanities, and Management at MIT. On March 1, 2002, Professor Cooney was appointed faculty director of the new Deshpande Center for Technological Innovation in the School of Engineering. He has continued his participation on the external review committee for the Department of Chemical Engineering of the University of Cambridge and was named a Cambridge-MIT Institute Fellow in March 2002.

Professor William M. Deen and the members of his laboratory continued their investigations in the areas of hindered transport in fibrous media, water and macromolecule filtration in kidney capillaries, and physico-chemical aspects of nitric oxide toxicity and carcinogenicity.

Professor Patrick S. Doyle was an invited lecturer at the University of Massachusetts at Amherst, Brandeis University, General Electric, and the Massachusetts General Hospital. Professor Doyle's group continues to investigate single molecule DNA dynamics and to develop mesoscopic simulations for studying polymer rheology. On the MIT campus, he developed a new Independent Activities Program (IAP) course for freshmen entitled "Hands-on ChE" with Professor Kenneth Beers.

Professor Alice P. Gast, vice president for research and associate provost, joined the MIT faculty and administration in November 2001. She has remained the co-chair of the National Research Council Board on Chemical Science and Technology and on the visiting committee for the Cornell University School of Chemical Engineering. Last fall she gave the Holtz Lectures at the Johns Hopkins University and was inducted into the National Academy of Engineering . She gave the Henske Lecture at Yale University and the plenary lecture at the 76th American Chemical Society Colloid and Surface Science Symposium in Ann Arbor, Michigan. She was awarded the University of Southern California School of Engineering Award for Academic Excellence. She has moved her laboratory and one student to MIT, graduated two students and has four remaining at Stanford University. Her National Aeronautics and Space Administration-sponsored research on magnetic fluids will be moved to the

International Space Station; her first experiment will be performed there this fall.

Professor Karen K. Gleason completed her first year as the department's executive officer. In this role, she won Institute approval for required changes to the undergraduate curriculum that enhanced the introductory and capstone experiences for undergraduate chemical engineering majors. Professor Gleason also led a department-wide curriculum review process this spring aimed at promoting more rapid introduction of examples from biology and advanced materials into the core undergraduate subjects. In addition, she gave invited presentations at Semicon Japan, the Eidgenössische Technische Hochschule in Zürich, Switzerland, Stanford University, the Pennsylvania State University, the University of Arizona, the Georgia Institute of Technology, Intel Corporation, and the DuPont Corporation. Together with two of her former PhD students, Professor Gleason co-founded GVD Corporation, the aim of which is to translate her laboratory's inventions for the vapor deposition of polymeric coatings to commercial applications in the membrane, medical device, and biopharmaceutical sectors.

Professor William H. Green, Jr. joined the editorial advisory board of the *International Journal of Chemical Kinetics* in January 2002. Professor Green continues to co-chair the sessions on Combustion Reaction Engineering for the American Institute of Chemical Engineers' annual meeting. He presented invited lectures on his research to the chemical engineering departments at Stanford University and the University of California at Santa Barbara, and at the American Chemical Society's Spring National Meeting. Professor Green wrote an overview of his work on computing rate constants from first principles for *Theoretical Chemistry Accounts*. On a more practical side, he invented a method for establishing the fundamental limits on achievable yields in complex catalytic processes, and a method for predicting the range of operability of novel homogeneous charge compression ignition (HCCI) internal combustion engines. Professor Green and Professor Herbert H. Sawin developed and co-taught the new subject 10.10 Introduction to Chemical Engineering for freshmen in the spring 2002 term. It is anticipated that this will become the first required subject for chemical engineering majors.

Professor Linda G. Griffith was promoted to full professor of chemical and biological engineering effective July 1, 2002. She is continuing to develop the LiverChip™ for study of liver physiology and detection of biowarfare agents and environmental toxins. Her work was profiled in May on the PBS series *Scientific American Frontiers*, hosted by Alan Alda. She is participating in the Cambridge-MIT Institute program and was chosen as a CMI fellow.

Professor Paula T. Hammond was promoted this year to associate professor with tenure in the Department of Chemical Engineering effective July 1, 2002. Professor Hammond's research work on directed assembly of colloidal particles on patterned surfaces was featured on the cover of *Advanced Materials*; the image, which was captured by Felice Frankel, was also featured in a photography text by Dr. Frankel just released by MIT Press. Professor Hammond was a key faculty member responsible for the identification, planning and writing of a proposal for the Institute for Soldier Nanotechnologies (ISN) at MIT. This major multidisciplinary research center, involving over 35 MIT faculty members, was funded for $50 million by the United States Army and is directed towards new technologies for the protection of the soldier. Professor Hammond is a member of the ISN executive committee, as well as the facilities coordinator and a research team leader in the ISN. She has given invited talks at the Gordon Conference on Polymers in Ventura, California, and the Polyelectrolytes 2002 Conference in Lund, Sweden. She was also an invited speaker at several companies and universities, including the University of Minnesota, the Georgia Institute of Technology, and Schlumberger.

Professor Jack B. Howard continues to serve as director of the Center on Airborne Organics involving MIT, the California Institute of Technology, and the New Jersey Institute of Technology. He was the Paul Chung Distinguished Lecturer in the College of Engineering at the University of Illinois at Chicago, and he received an honorary doctor of engineering degree from the Colorado School of Mines.

Professor Klavs F. Jensen was elected to the National Academy of Engineering. In collaboration with colleagues at MIT, he continued research on microfabricated chemical systems for chemical and biological synthesis and analysis, microsystems for fuel processing, on multiscale modeling of reactive processes for thin film deposition, and quantum dot composite materials for optical devices. The MicroChemical Systems Technology Center was started in his laboratory with the support of eight international chemical and pharmaceutical companies. Professor Jensen was also principal investigator for the new MIT Multidisciplinary University Research Initiative program on microchemical systems for conversion of fuel to electrical power. This program involves researchers from a number of departments across the School of Engineering. He participated with colleagues from the Departments of Biology, Chemical Engineering, and Electrical Engineering and Computer Science in a DuPont-MIT Alliance research project on microfabricated bioprocessors. He co-chaired the National Research Council Workshop on Materials and Processes as a part of the NRC's survey of chemical sciences. As the 2002 L. K. Doraiswamy Lecturer he presented lectures at the Iowa State University and the

Indian National Chemical Laboratory in Pune, India. He also gave the 2002 Donald L. Katz Lectures at the University of Michigan at Ann Arbor. He gave several invited presentations on microchemical systems and at national and international conferences and at universities.

Professor Robert S. Langer is the Kenneth J. Germeshausen professor of chemical and biomedical engineering at the Massachusetts Institute of Technology. Professor Langer was honored by the National Academy of Engineers with the 2002 Charles Stark Draper Prize, the world's most prestigious engineering prize, which carries an award of $500,000. He received an honorary doctorate from the Hebrew University of Jerusalem in Israel in 2002. He also received the Othmer Gold Medal from the Chemical Heritage Foundation and the 2002 Nagai Innovation Award from the Controlled Release Society. He was the 2002 distinguished lecturer at the University of Louisville in Kentucky, the 2002 institute lecturer of the American Institute of Chemical Engineers, the 2001 Ullyot lecturer of the Chemical Heritage Foundation, the 2001 Clapp lecturer at Brown University, the 2001 Julian Smith lecturer at Cornell University, the 2001 Mason lecturer at Stanford University, and the 2001 distinguished lecturer at Carnegie Mellon University. *Time Magazine* named him one of the 100 Most Important People in America (in the article "America's Best") and one of the 18 Most Important Individuals in Science and Medicine in the United States. *Discover Magazine* also named him one of 20 Biotech Geniuses to Watch.

Professor Douglas A. Lauffenburger was elected this past year to membership in the National Academy of Engineering and the American Academy of Arts and Sciences. At MIT, he continues as co-director of the Biological Engineering Division, formerly the Division of Bioengineering and Environmental Health, director of the Biotechnology Process Engineering Center, and associate director of the DuPont-MIT Alliance in bio-based materials. At the national level, he is serving on the advisory council for the National Institute of General Medical Sciences, and this current year is chair of the College of Fellows of the American Institute of Medical and Biological Engineering.

Professor Paul E. Laibinis delivered invited seminars at Rice University, Rensselaer Polytechnic Institute, the Johns Hopkins University, the Massachusetts General Hospital, Notre Dame, Texas A&M, and North Carolina State Universities, the Universities of Houston and of Maine, Tufts and Columbia Universities, the City College of New York, and various industrial laboratories. He gave invited presentations at the 2d Chemical Engineering Conference for Collaborative Research in the Eastern Mediterranean in Turkey, an international conference on "Self-Assembly: The Future" in Italy, and various domestic meetings on his group's development of a new class of chemical sensors and gene chips. For his efforts in surface engineering, he was selected by the Information Sciences Institute in 2002 as being among the top-cited authors in the area of molecular self-assembly during 1981–1999. He serves on the editorial boards of the journals *Langmuir* and *Sensors* and the Victor K. LaMer Award Committee of the Colloid and Surface Chemistry Division of the American Chemical Society. Professor Laibinis is also a faculty fellow in the Singapore-MIT Alliance Program on the Molecular Engineering of Biological and Chemical Systems. In January 2003, Professor Laibinis will join the chemical engineering department at Rice University.

Professor Gregory C. Rutledge is currently serving as director of the Program in Polymer Science and Technology at MIT, an interdisciplinary educational program that draws a small but elite group of graduate students to MIT for polymer studies. He has continued his research to develop improved tools for the atomistic modeling of polymeric materials and on electrospinning of polymer nanofibers. He is a team leader for processing and characterization in the new Institute for Soldier Nanotechnologies at MIT, as well as a continuing investigator in the Center for Materials Science and Engineering, the Center for Advanced Engineering Fibers and Films, the National Textile Center, and the Air Force Program on Nanocomposites at MIT. Over the past year he has delivered a number of invited talks, including those at the European Polymer Society, the Centre Européen de Calcul Atomique et Moléculaire at the École Normale Supérieure in Lyon, France, the American Society of Mechanical Engineers, Gordon Research Conference on Composites, the Flory Award Symposium of the American Chemical Society, the International Symposium on Polymer Crystallization in Mishima, Japan, and several academic institutions. He continues to serve on the editorial boards of *Polymer* and *Computational and Theoretical Polymer Science*, and co-teaches the ACS short course on Molecular Modeling of Polymers.

Professor Herbert H. Sawin developed, in collaboration with Professor William H. Green, Jr., a new introductory course for the chemical engineering curriculum, 10.10 Introduction to Chemical Engineering. This course combines instruction in mass and energy balances, engineering problem solving, and MATLAB programming. Professor Sawin was made a fellow of the American Vacuum Society. He gave an invited talk at the Electrochemical Society Plasma Symposium on the use of multivariate statistics for the analysis of optical emission in the identification of endpoint in plasma etching processes. He gave a chemical engineering departmental seminar at the University of California at Los Angeles.

Professor Kenneth A. Smith has continued his research on the roles of fluid mechanics and transport phenomena in a number of contexts. These include use of the supercritical

water oxidation process for destruction of organic wastes, jointly with Professor Jefferson W. Tester, and the dynamics of micellar self-assembly, jointly with Professor T. Alan Hatton. He is also engaged in the development of an instrument that can determine the size-segregated chemical composition of an aerosol and do so in real time. He is participating in the Molecular Engineering of Biological and Chemical Systems program within the Singapore-MIT Alliance. In addition, he delivered invited lectures at Tsinghua University in Beijing, China, and at the Eidgenössische Technische Hochschule in Zürich, Switzerland.

The central goal of Professor Gregory Stephanopoulos's educational and research activity is to extend the chemical engineering paradigm to the analysis and design of biological systems, thus developing a foundation for chemical and biological engineering at MIT and nationally. This requires increasing biological content in the chemical engineering curriculum and tighter integration between biology and engineering. The current Bayer professor of the department, his efforts were recognized in the fall of 2001 by the American Institute of Chemical Engineers Wilhelm Award in chemical reaction engineering, the 2002 Merck Award in metabolic engineering and the 2002 *CIO Magazine* 20/20 Vision Award honoring 20 academic (and 20 industrial), visionary leaders in information technology for pioneering work in biological data mining and bioinformatics. Professor Stephanopoulos continued as co-editor of the journal *Metabolic Engineering*, published by Elsevier Academic Press. In addition, he serves on the editorial boards of seven other scientific journals. He delivered plenary lectures at the 10th European Conference in Biotechnology in Madrid, Spain in July 2001, the Bioinformatics Gordon Research Conference in August 2001, the Princeton Symposium on Metabolic Engineering in December 2001, the Conference on New Biology at the University of Illinois at Urbana-Champaign in March 2002, the European Symposium on Biocatalysis in Como, Italy, in May 2002, and the Annual DECHEMA (the German Association of Industrial Chemists) Meeting in Wiesbaden, Germany in June 2002. He was also the 2002 Merck lecturer at the University of Virginia and at the Rutgers University Distinguished Lecture series. Professor Stephanopoulos also participates in the DuPont-MIT Alliance, is a fellow of the Singapore-MIT Alliance and a member of the International Faculty of the Technical University of Denmark.

After serving as the director of the Energy Laboratory for the past 12 years, Professor Jefferson W. Tester decided to step down and resume his responsibilities as a faculty member in the department. He continues to be active in the energy area where he remains as chair of the National Advisory Council of the Department of Energy's (DoE) National Renewable Energy Laboratory and co-chair of the Governor's Advisory Board for the Massachusetts Renewable Energy Trust. Professor Tester also continued as a member of the advisory groups for the Paul Scherrer Institute, which is part of the Eidgenössische Technische Hochschule (ETH/Swiss Federal Institute of Technology) in Zürich, Switzerland and the Nuclear and Energy Systems Division of the Idaho National Engineering and Environmental Laboratory. Last year, while on sabbatical, he gave invited lectures at Rensselaer Polytechnic Institute, the National Renewable Energy Laboratory, Los Alamos National Laboratory, the Conference on World Affairs at the University of Colorado, and provided invited testimony at several US government hearings and forums on distributed energy and renewable energy and on sustainable waste treatment. He was also the recipient of the department's Outstanding Faculty Award.

Professor Bernhardt L. Trout was named the Henry C. and Grace Doherty professor of ocean utilization for his work on clathrate-hydrates. He was awarded an NSF CAREER grant for his work with solid-acid zeolyte catalysis. In addition, he has been granted a Ford Motor Company Young Investigator Award. He has given invited talks at the National University of Singapore, the National Research Council of Canada, and the California Institute of Technology, in addition to the American Institute of Chemical Engineers and the American Chemical Society. Funding for his projects on chemical and process design via molecular understanding is provided by the National Science Foundation, the Department of Energy, the National Aeronautics and Space Administration, Amgen, Inc., and the Ford Motor Company.

Professor Daniel I. C. Wang was the keynote lecturer at the Society of Industrial Microbiology/American Chemical Society (ACS) in November 2001 at their annual meeting held in Long Beach, California. Professor Wang chaired the National Science Foundation's Workshop on the Future of Biochemical Engineering" He was awarded the Taiwan Semiconductor Corporation Professor Lectureship and delivered two lectures at Tsing Hua University, Hsinchu, Taiwan, in June 2002. He delivered the keynote lecture at the 7th Asian Biochemical Engineering Conference at Taipei, Taiwan, in July 2002. He was invited by the Institute of Chemical and Engineering Sciences in Singapore to be a member of the Scientific Advisory Board for a three-year appointment. In addition, he was invited to deliver an address at the 2d Meeting of the MIT Club of Germany in Munich in November 2002. Lastly, he was also invited to deliver the keynote address on "Trends in Biotechnology" to be held in Vienna, Austria, in November 2002.

Professor Jackie Y. Ying delivered fourteen invited lectures at various international conferences and national meetings during the past year, including plenary lectures at the Third International Symposium on Mesostructured Materials in Korea and the Fourth World Congress on Particle

Technology in Australia. She served on the scientific/programming committee of the Sixth International Conference on Nanostructured Materials, and on the organizing committee of the Second Japan-America Frontiers of Engineering Symposium. Professor Ying was the inaugural G.-J. Su distinguished lecturer at the University of Rochester and an invited seminar speaker at the University of California at Los Angeles. She serves on the editorial boards of seven journals/book series, as well as on the advisory boards of the Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden in Germany, the University of Queensland Nanomaterials Centre in Australia, and the National Research Council Steacie Institute for Molecular Sciences in Canada. Professor Ying is an honorary professor of chemistry of Jilin University in China, a director of the American Institute of Chemical Engineers' Materials Engineering and Sciences Division, and an executive committee member of the American Chemical Society's Colloid and Surface Chemistry Division. She chairs the Singapore-MIT Alliance Program on Molecular Engineering of Biological and Chemical Systems.

Other faculty members of the department include assistant professor Kenneth J. Beers, Professor Clark K. Colton, Professor T. Alan Hatton, Professor Gregory J. McRae, Professor George Stephanopoulos, associate professor Preetinder S. Virk, and Professor K. Dane Wittrup, as well as senior lecturers Dr. Barry S. Johnston and Dr. C. Michael Mohr.

Research Highlights

Electrospinning of Polymer Fibers

Professor Gregory C. Rutledge

Electrostatic fiber spinnning, or "electrospinning", is a technology that uses electric fields applied to charged fluid streams to produce polymeric fibers that are typically hundreds of nanometers in diameter, two to three orders of magnitude smaller than fibers produced by conventional extrusion methods, and three orders of magnitude smaller than the typical human hair. Materials manufactured from such fibers exhibit potentially unusual fiber morphologies, very high porosity (e.g., >90%) and surface area (hundreds of square meters per gram), and pore sizes that can be varied over a wide range, from 1 to 1,000 microns. These materials are attracting interest in applications as diverse as filtration and membranes, composites, biomimetic materials for tissue engineering, drug delivery, and electronics.

Professor Rutledge's group has been developing the fundamental understanding required to operate and scale up this process for practical use. The process itself involves charging a polymeric fluid, for example by raising it to a voltage of 10-30 kV, in an electric field. The charged fluid ejects a jet that is then accelerated downfield to a collection device maintained at a lower potential. En route to the collector, the charged fluid stream undergoes one or more fluid instabilities, resulting in a jet that whips around in space, thereby rapidly stretching the fluid filament to ever smaller diameters. As the filament dries, the solid fibers are conveyed to the collector, where a nonwoven material or yarn is obtained. Using high-speed photography, the Rutledge group was among the first to identify the nature of these instabilities and to capture them on film. A particularly illuminating example has appeared in Felice Frankel's recent book *Envisioning Science: The Design and Craft of the Science Image* (MIT Press, 2002).

In collaboration with Professor Michael Brenner of Harvard University, a simple analytical electrohydrodynamic model for a slender charged jet in an electric field has been developed and tested against carefully designed experiments on model fluids. Using a linear instability analysis, the origins of several varicose and whipping instabilities have been identified and quantified. This synergy between theory and experiment has resulted in new insight regarding what are the controlling parameters during electrospinning, and has directed development of the technology in new directions. The theory permits the elaboration of design principles, operating diagrams and scaling relations that help the engineer to apply the technology to new materials and obtain new products.

In MIT's new Institute for Soldier Nanotechnologies, electrospinning represents one of the key technologies for fabricating integrated, multifunctional textiles with nanoscale structure. By confining polymer molecules to fibers with diameters less than 100 nm, new morphologies and properties are expected for these fibers. Such fibers may be used to create composites for ballistic and other impact protection. Fibers in this size range are also better mimics of naturally occurring fibrils in the extracellular matrix of tissues than are more conventional fibers. The feature, combined with other qualities of electrospun materials such as high porosity and controllable pore size, offers promise for these materials in biomedical applications. The envisioned textiles also have filtration and chemical remediation specifications for chemical and biological warfare protection; for these purposes, nanofiber-based nonwoven fabrics are uniquely suited.

Engineering Superior Cells

Professor Gregory Stephanopoulos

As lately hardly a day passes without yet another biological breakthrough, you may have asked your microbiologist friend whether she or he knows of a microbe capable of producing the molecule of your choice. In the unlikely event that one is not readily available, she or he may suggest some other microbe that makes a similar product that can be converted to the desired one, or, better yet,

your microbiologist friend will formulate some screen to select microbes and their mutants that can produce a whole family of similar products with potentially better properties than the one initially sought. The problem with most such candidate organisms is that they only make traces of the desired molecule and under conditions that may be difficult to implement on an industrial scale. These microbes must be improved before their potential can be realized. If you are similarly concerned about a particular disease, you may want to know how a newly discovered gene, or some other gene(s) buried in the sequenced genome, can help discover a drug for the disease or define a strategy for gene therapy. The answer to these questions depends critically on how well we can characterize the physiological state of cells and tissues and use this information to prescribe the necessary genetic changes and/or environmental controls to improve such cells. This is also the goal and essence of metabolic engineering, the area of interest of Professor Gregory Stephanopoulos.

To achieve the above goal, the Stephanopoulos laboratory makes use of state-of-the-art tools such as DNA microarrays for transcriptional profiling; stable isotopic tracers, in conjunction with software for metabolic pathway reconstruction, for the determination of metabolic fluxes in bioreaction networks; and advanced bioinformatics methods for data mining and determination of discriminatory genes and characteristic gene expression patterns. Besides research carried out on further developing the above methods, the latter are also profitably deployed for the study and improvement of various systems of medical and biotechnological interest. Thus, we have investigated amino acid production in fermentations of *Corynebacterium glutamicum* where we succeeded in increasing the specific productivity of lysine threefold through the simultaneous amplification of two important genes. In collaboration with scientists from Merck & Co. we increased the yield of a key precursor in the manufacturing of the AIDS drug Crixivan® from 25 percent to better than 95 percent through metabolic engineering of the bioconversion pathway of this organism. Our methods allow us now to determine pathway fluxes *in vivo* at high resolution using advanced gas chromatography-mass spectrometry (GC-MS) instrumentation, identify important genes and their characteristic expression pattern associated with highly productive strains or the onset of disease, and deploy these tools for the modification of cells for industrial and medical applications.

Presently we are investigating the mechanisms of carbon dioxide fixation by photosynthetic cyanobacteria and its conversion to useful products, such as biopolymers. In particular, we are engineering strains that have enhanced capability for biopolymer production under the hypothesis that increased product formation will also lead to increased fixation of CO_2. These improved cyanobacteria will thus be able to remove CO_2 from the flue gases of power plants in shallow ponds and convert this greenhouse effect gas to a useful product that is also biodegradable. Another system under investigation is the metabolic pathways associated with diabetes and obesity. The novelty of our approach is that we take an *integrated* view of all pathways of relevance to this disease inflicting more than 15 million Americans. Specifically, while critical enzymatic reactions and pathways of importance to diabetes have been adequately described at the biochemical and genetic levels, our understanding of the integrated behavior of these pathways and the factors impacting flux distribution among such pathways is quite limited. As a result, there are many reasons that can lead to the same diabetic phenotype of hyperglycemia (i.e., elevated blood sugar concentration) but it is not possible to identify the specific causes of diabetes in a particular individual. Detecting such mechanisms for each individual would provide the basis for prescribing the right medication and also developing new drugs with better efficacy and broader applicability in the treatment of this disease. To this end, our methods of flux determination and transcriptional profiling are deployed along with bioinformatics tools in the study of cell culture model systems and in and animal experiments.

One such study, presently underway in collaboration with scientists from the Beth Israel Deaconess Medical Center (BIDMC), investigates the transcriptional profiles, hormonal levels and diabetic phenotype in diabetic-prone and normal mice under a variety of dietary conditions. As the diabetic phenotype develops in the course of this experiment, gene activity profiles are measured by DNA microarrays to determine those genes whose expression is altered as hyperglycemia develops. This type of information will provide powerful clues about the molecular mechanisms of hyperglycemia and help the discovery of effective drugs for the treatment of diabetes.

Annual Seminars, Presentations, and Lectures

Thanks to the untiring efforts of Professors Bernhardt L. Trout and William H. Green, Jr., the fall and spring seminars were again quite successful and attracted academic and industry leaders from esteemed institutions such as our own MIT, Princeton, Yale, and Northwestern universities, the universities of Wisconsin at Madison and Illinois at Urbana-Champaign, the Georgia Institute of Technology, the Technical University of Denmark, among a host of others, and highly respected industrial organizations such as Mitsubishi Chemical Corporation, Genzyme Corporation, and Symyx Technologies, Inc.

The department is fortunate once again to have successfully presented its series of four annual major lectures: the 3d Frontiers in Biotechnology Lecture, delivered by George M. Whitesides, Mallinckrodt Professor of Chemistry at

Harvard University, and the 16th Hoyt C. Hottel Lecture, delivered by Kevin O. Myers, president and CEO of Phillips Alaska, Inc. in the fall term; and the 8th Alan S. Michaels Lecture, delivered by Henri Termeer, CEO of Genzyme Corporation and the 24th Warren K. Lewis Lecture, delivered by Ulrich "Ueli" W. Suter, professor of macromolecular chemistry in the Department of Materials at the Eidgenössische Technische Hochschule (ETH/Swiss Federal Institute of Technology) in Zürich, Switzerland, in the spring term. During the 2001–2002 academic year, a special lecture by the department's own Professor Gregory Stephanopoulos was delivered as part of his acceptance of and inauguration as the new Bayer professor of chemical engineering. The previous holder of the Bayer professorship was Professor Gregory J. McRae.

Departmental Awards

During the year just ended, the department awards ceremony took place on May 13, 2002, in the Gilliland Auditorium of the Ralph Landau Building. We are pleased to recognize this year's recipients of the Outstanding Faculty Awards—Professor E. Daniel Blankschtein, as chosen by the graduate students; and for the second year in a row, Dr. C. Michael Mohr was honored by the undergraduate students.

The Edward W. Merrill Outstanding Teaching Awards are conferred to two graduate students each year. The Outstanding Teaching Assistant Award was presented to third-year graduate student Kimberly Bryan-Kosto and the Outstanding Graduate Student Instructor Award went to fifth-year graduate student Matthew Lazzara, both for their work in 10.302 Transport Processes.

Chemical Engineering Special Service Awards were conferred to the president of the Graduate Student Council, Jason Kralj, for overall distinguished service, and to Reuben Domike and Roger Aranow for service in organizing intramural sports. In addition, Reuben Domike was also awarded the "Chemical Engineering Rock" for outstanding athleticism. All third-year graduate students are required to present a seminar on the progress of their research and the two recipients of the award for outstanding seminar delivered were Geoffrey Moeser and Kevin Dorfman.

Our undergraduates also earned numerous accolades over the course of the year. In addition to winning the prestigious Barry S. Goldwater Award, Bradley D. Olsen also received the Dow Chemical Company Outstanding Junior Award for excellence in balancing academics, social and professional organizational commitments, and work experience. Rising seniors Bukola Aina and David Yin were each awarded a Merck Fellowship. The Robert T. Haslam Cup, which recognizes outstanding professional promise in chemical engineering, went to Hiroki Kaido; and finally, the Roger de Friez Hunneman Prize, the oldest prize in the department and is awarded to the undergraduate who has demonstrated outstanding achievement in both scholarship and research, went to K. Jaisel Vadgama.

The department is quite pleased to recognize Susan D. Lanza, assistant to professors William H. Green, Jr., George Stephanopoulos, and Daniel I. C. Wang, as the department's outstanding employee of the year. Ms. Lanza was elected by her peers and the graduate students for having provided unrivaled dedication and outstanding service to faculty, staff, and students. Annie Fowler, the assistant in the Graduate Student Office, was awarded the Individual Accomplishment Citation for her dedication to the department and hard work on behalf of the graduate students.

The Department of Chemical Engineering at MIT has certainly had a very fruitful and rewarding year in 2001–2002 and is poised for even bigger and greater successes for the upcoming year.

Robert C. Armstrong, Department Head and Chevron Professor of Chemical Engineering
Karen K. Gleason, Executive Officer and Professor of Chemical Engineering

More information about the Department of Chemical Engineering can be found on the web at http://web.mit.edu/cheme/index.html/.

Department of Civil and Environmental Engineering

The Department of Civil and Environmental Engineering serves a profession distinguished by complex interactions among large constructions, the natural environment and human activities. We aim not only at contributing to economic prosperity and improved quality of life for this generation, but also at a balanced development so that resources and the environment can be sustained for all future generations.

The recent tragedy at the World Trade Center highlighted the challenges to the profession on a new front: the security of our society. In order to meet present and future challenges, this department emphasizes a multidisciplinary approach by drawing expertise from and educating young engineers in the natural and social sciences, management and systems sciences, as well as computer technologies. This intellectual diversity is reflected in our three-pronged organizational structure:

- Engineering Systems Group (transportation, construction management and information technology)
- Environmental Systems Group (aquatic biology, chemistry and ecology, environmental fluid mechanics and coastal engineering, surface and subsurface hydrology)
- Engineering and Environmental Mechanics Group (structural materials and condition assessment, earthquake engineering, geotechnical and geo-environmental engineering)

Our specific objectives are to train future leaders capable of developing new knowledge in environmental sciences and engineering; physics and the design of construction materials, man-made and natural; planning and management of large scale constructions; information systems for large infrastructures and the natural environment; and system methodologies for integrating the design, finance and management of complex systems in the built environment, on all scales (local, regional, national or global) and including policy, social and cultural elements.

Initiatives

I-city

The city of the future is envisioned as a digital city where the infrastructures are intelligent, integrated and IT-enabled. The development of concept and prototype of an I-city is to create the digital nerve system that streamlines the planning and operation of an entire city. Combining sensors, control systems, modeling and simulation, data collection and decision-making systems, this nerve system shall optimize the independence and the intra-dependence of entire infrastructural subsystems such as power, communications, buildings, water supplies, hospitals, etc., in peace times as well as in emergencies. The urgency of this visionary initiative is made clear by the tragedy of September 11. In addition to the pilot project on Flagpole supported by I Campus, a new proposal has been submitted to Cambridge-MIT Initiative. A new teaching laboratory on sensing and information technology is being set up.

Earth Systems Initiative

With a view to directing some of the technological advances toward understanding our home planet, our faculty (led by Professors Penny Chisholm and Rafael Bras) and the faculty of EAPS (led by Professors Kip Hodges and Ron Prinn) have spearheaded the Earth System Initiative. The initiative will serve as a research and educational focus combining geosciences, biology and engineering. With the financial support of MIT, a first step has been launched to develop a new educational program, Terrascope, for freshmen. Terrascope will use the Earth system as a theme for exploring interactions among physical, chemical, and biological processes, in order to explore possible engineering solutions to problems related to the evolution of our planet and its environment. The new program will include three components: a pre-freshman offering, aimed at introducing incoming students, regardless of their probable majors, to interdisciplinary problems in the Earth sciences and to help them develop effective learning cadres; a freshman educational program designed to reinforce concepts learned in the Science Core and other General Institute Requirements by focusing on applications to problems in Earth science and engineering; and an expansive undergraduate research program aimed at providing rising sophomores with summer UROP experiences that may carry over to the sophomore year. Professors Chisholm (CEE) and Hodges (EAPS) are the co-directors of Terrascope.

Educational Activities

Undergraduate Program

In the past decade there is nationwide trend of low enrollment in civil and environmental engineering. Inclusion of environmental engineering has led to considerable recovery of the trend; see the table below. Aiming at increasing the undergraduate enrollment, Professor Herbert Einstein and Dr. George Kocur are proposing the 1-I program focusing on information technology in civil engineering.

The vitality of our undergraduate program is boosted by the internship program and the study tours in foreign countries. Last year 27 students participated in the summer intern program sponsored by 41 companies in US and abroad, including Hong Kong, Australia, Japan, China, and Italy.

Number of Students Enrolled in CEE in the Past Six Years

	AY98	AY99	AY00	AY01	AY02
Undergrad	102	82	76	69	62
MS	190	128	132	122	139
MEng	34	35	47	66	41
PhD, ScD	75	85	100	101	94
Special	0	0	6	1	1
Total	299	248	279	289	275

Master of Science and Master of Engineering Programs

Our MS program has the traditional emphasis on thesis research and serves well as a preparation for doctoral studies. The total number has remained steady in the past four years despite the recent difficulty in research funding in certain areas. Our MEng program has risen and fell. Because the rising quality of incoming MEng students, they now are a new source for potential doctoral students. The reduction of MEng class in 2000-2001 (in high performance structure and geotechnical engineering) appears to be temporary, as the projected class size for 2002-2003 is about 70. Led by Dr. Eric Adams, we have recently obtained a four-year grant from the Cambridge-MIT Institute (CMI) to help Cambridge University develop a one-year MPhil program, patterned after the MEng program in CEE. The objectives there are to develop teaching modules on sustainable water and sanitation projects in the developing world, sustainability of large-scale water resources projects, sensing and control of buildings and e-commerce and business development.

Doctoral Program

The size of our doctoral class has risen in recent years, due in part to the increasing diversity of our programs. Demands (from industries, government and academia) of our doctoral graduates remain high. MIT's CEE department is a major source of new faculty for universities around the world.

I campus Projects

The Flagpole project is a pilot project for the I-city initiative, aiming at employing information technology to monitor the infrastructural health of a city. Sponsored by I Campus as one of several I-Labs projects, Professor Kevin Amaratunga continues to develop a sensing and monitoring system for a flagpole through the internet. He and nine master's students are obtaining displacements, accelerations, stresses, strains and the ambient temperature. Their goals include not only obtaining valid streaming data, but also setting up a foundation for further monitoring and decision support studies at MIT. The flagpole instrumentation project is closely related to the photovoltaic weather station project, which monitors environmental parameters such as wind speed, wind direction, rainfall, temperature, etc and makes them available on the internet in real time.

Professors Chiang C Mei, Heidi Nepf and five other colleagues from Mechanical Engineering, Ocean Engineering, Mathematics and Physics Departments are continuing the development of an Institute-wide modular program on graduate-level fluid mechanics. The intention is to improve teaching effectiveness by employing information technology, visual demonstrations and numerical simulation, with the eventual goal to consolidate existing subjects to reduce redundancy. A module on fluid wave motion is already complete; new modules on and experimental techniques and slow viscous flows are now being developed by Nepf and Mei respectively, to complement modules being developed by colleagues in other departments on fundamental laws, molecular foundation of continuum equations, high Reynolds number flows, surface tension and potential flows.

In a joint project with the Department of Aeronautics and Astronautics, Professor Herbert Einstein continues to lead the development of IT-based learning modules, collaborative tools and interactive learning procedures to facilitate the interaction of students with the learning instruments, with each other and with instructors. Simulation is used extensively in the learning modules. Video-conferencing softwares enable remote interactions. Handheld devises are used by students to submit questions or responses in real time.

Robot World is the new project led by Professor John Williams. The focus is on e-education.

Faculty Research Accomplishments and Activities

Engineering Systems Group

Professor Cynthia Barnhart was promoted to professor on July 1, 2002. In addition to a full load of teaching and research, she serves in three capacities of leadership: co-director of the Center for Transportation Studies, Operations Research Center and Leader of Engineering Systems Group. With Professor Amedo Odoni she is co-supervising a large project on airline operations and custom service, funded by the Alfred Sloan Foundation. She further took part in designing two subjects: Airline Industry and Transportation Operations, Planning and Control: Carrier Systems.

In the Intelligent Transportation Systems Program directed by Professor Moshe Ben-Akiva, collaborative research programs have been established with seven foreign universities and the US. MITSIMLab, a microscopic traffic simulator developed at the ITS program, was the focus of an automotive and traffic segment on a recent broadcast of the *Discovery Channel Canada*. DynaMIT, a dynamic traffic assignment system that works in conjunction with MITSIMLab, received notice as well from MIT's *Technology Review* magazine in 2001.

With colleagues from MIT and Cambridge, Professor Ismail Chabini started a research project, "Sentient Vehicles"; to develop network-level vehicle-based technological solutions to problems related to mobility and the environment. He also leads a new initiative within the Ford-MIT alliance, on motor vehicle safety. He received the 2002 Best Teaching award from the MIT Center for Transportation and Logistics, and serves as chair of the INFORMS transportation science section committee on the best dissertation prize for year 2001.

The 2001 Effective Teaching Assistant award in CEE goes to Dr. George Kocur for the popular undergraduate staple 1.00 Introduction to Computers and Engineering Problem Solving and the graduate subject 1.264 Database, Internet, and Systems Integration Technologies.

Professor Richard de Neufville was elected as a fellow at Clare Hall of Cambridge University. The Technical University of Delft awarded Professor de Neufville an honorary doctorate at their 160th anniversary in January 2002, in recognition of his success in establishing the field of technology policy. At MIT, the Technology and Policy Program presented the Best Teacher award to Professor de Neufville.

Professor David Marks has been named to the Morton '42 and Claire Goulder family chair in environmental systems. He now heads the new Laboratory for Energy and Environmental Systems, which is a merger of two groups—the Energy Laboratory and the Center for Environmental Initiatives. In recognizing his leadership in creating the Chalmers Environmental Initiative, he was awarded an honorary doctorate by Chalmers University, Sweden, in May 2002.

One of this year's highlights for Professor John Miller is the publication of his second textbook on *Case Studies in Infrastructure Delivery* (Kluwer). This book complements his first entitled *Principles of Public and Private Infrastructure Delivery*, published last year, which has won critical acclaim by professional journals.

Professor Fred Moavenzadeh has just published a book entitled *Future Cities: Dynamics and Sustainability* (Kluwer Academic Publishers 2002) He was awarded on May 15, 2001 Bronze Order of the deFleury medal by Lieutenant General Robert Flowers, chief of engineers, US Army Corps of Engineers.

Professor Ruaidhri O'Connor used part of his first year appointment to set up a new teaching laboratory on sensing and information technology. The laboratory will focus on infrastructure monitoring and management, and will become an essential part of the I-city initiative.

INFORMS also gave the Robert Herman lifetime achievement award in transportation science to Professor Amedeo Odoni (CEE and Aeronautics/Astronautics) for his "fundamental and sustained contributions to transportation science."

Professor Feniosky Pena-Mora has signed with Prentice Hall for the publication of a new text, *Introduction to Construction Dispute Resolution*. He is working on two other books at the same time: *System and Project Management*, and *Interaction Space for Designing and Managing Dispersed Work and Learning Environments*.

Professor Yossi Sheffi organized a summer course in supply chain management (June 2002) and a CMI course in supply chain management (with David Simchi-Levi and Professor Duncan McFarlane of Cambridge University).

Together with Professor Charlie Fine from Sloan, Professor David Simchi-Levi has established the "MIT Forum on Supply Chain Innovation" with funding from SAP and committed funding from British Telecom. He presented two keynote lectures: one at the Canadian Operational Research Society annual meeting, June 2002, and one at the third CLM Delaware Valley roundtable, May 2002. He was interviewed by *Parcel Shipping and Distribution* for the article "On the Horizon: Postal service to Realign vast Network," May 2002, and by *InBound Logistics* in April 2002 for the article "Supply Chain Planning in a Global Economy." His book *Designing and Managing the Supply Chain* was selected in the *Business 2.0*, December 2001 issue, as the best source for slashing time and cost and increasing productivity in the supply chain.

Professor Joseph Sussman received the Transportation Research Board's Roy W. Crum Award, its highest honor, in January 2002, for contributions to research on railroads, intelligent transportation systems, and other large integrated systems. The Intelligent Transportation Society of Massachusetts established the Joseph M. Sussman Leadership Award in April 2002. Professor Sussman also won the MIT Technology and Policy Student Society Faculty Appreciation award for 2002 for his work in ESD.10, a new, introductory required subject in the Technology and Policy Program.

During his European sabbatical, Professor Nigel Wilson did research at Delft University as part of the seamless intermodal transportation program of the TRAIL Research School and participated in several short courses, including one on rail capacity analysis and another on options for restructuring urban public transport provision. At Napier University in Edinburgh, he did research on the most recent ramifications of bus deregulation in Great Britain focusing on the implications of on-street competition in service provision on service quality, fares, and coverage.

Engineering and Environmental Mechanics Group

Professor Oral Buyukozturk delivered the keynote lecture on the use of high performance materials in tall building

design in the symposium on *Building a Safer, Stronger New York City* sponsored by the New York Structural Engineering Association. Following several mutual visits, Mr. Michael Parlamis of New York has donated to the department $250,000 for fellowships in our structural engineering education program.

Professor Jerome Connor developed a new research initiative on sensing and monitoring physical infrastructures using MEMS based sensors and actuators. He introduced a new subject 1.962 in the fall on MEMS. He has submitted the final version of a new text on *Structural Motion Control* to be published by Prentice Hall.

Professor Patricia Culligan was appointed to the National Research Council's committee on long-term institutional management of DOE waste sites. In addition, she was awarded a faculty fellowship from the Center of Academic Excellence at the Idaho National Engineering and Environmental laboratory. In conjunction with Professor Herbert Einstein, Professor Culligan is co-directing the 12th Panamerican Conference on soil mechanics and geotechnical engineering and the 39th US Rock Mechanics Symposium, to be held in Cambridge, Massachusetts in June 2003.

Professor Herbert Einstein was invited to deliver the keynote lectures at both the International Landslide Conference in Davos, and at the 50th Geomechanics colloquium in Salzburg. In September the CEE department also presented him a special service award for his outstanding services to the undergraduate program. Together with Dr. George Kocur, he is proposing a new undergraduate program (1-I) in information technology. He also led the preparation for ABET site review on our 1C program which received excellent rating for the department.

Professor Eduardo Kausel achieved considerable media recognition with his studies of the collapse of the World Trade Center towers. In October of last year, he and Professors Buyukozturk and Connor staged a public discussion at MIT on the WTC. This forum motivated an article in the November issue of *Scientific American*. He also appeared in a documentary on the WTC that aired last January around the world. His analyses of the relationship between speed of the aircraft and damage to the towers made front page news in the New York Times last February, which was then carried by major news media, including the CBS Evening News. He was interviewed by the BBC in London, and by Emily Rooney in Channel 2 in Boston. This month, Kausel and five of his colleagues have submitted for publication a book manuscript with the title *Lost Towers and Beyond.*

During its annual meeting last May, the International Union of Testing and Research Laboratories for Materials and Structures (RILEM) announced the Robert L'Hermite award to Professor Franz Ulm. He will receive the award and deliver the award lecture in Madrid in September. Aside from a prolific output in journal publications, Ulm will celebrate later this year the publication of his first book, *Mechanics and Durability of Solids*, vol. 1, authored jointly with Professor Olivier Coussy of Paris.

Professor John Williams has made significant advances on coupled lattice-Boltzman fluid and particle mechanics to simulate particle-laden fluids. This study has applications in oil recovery, biomechanics and pharmaceuticals and nanoscale materials. It has led to new work on drug manufacturing processes and to the establishment of Sandia fellowships for MIT doctoral candidates.

In January 2002, Professor Andrew Whittle was a keynote lecturer at an international conference on advances in civil engineering, held to celebrate the 50th anniversary ("Golden Jubilee") of the Indian Institute of Technology, Kharagpur. He and professor emeritus Charles Ladd, along with Charles Aubeny (former student of Whittle's now at Texas A&M University), were awarded the 2002 Thomas A. Middlebrooks Award by the American Society of Civil Engineers for a paper entitled "Effects of disturbance on undrained strengths interpreted from pressure-meter tests."

This was a year of bumper harvest for Professor Shi-Chang Wooh, who registered 13 publications in prestigious journals related to composite materials and nondestructive evaluation. He has been invited to serve on the advisory board of the *Journal of Nondestructive Testing and Evaluation International*. In the first Mehl Honor Lecture at the American Society of Nondestructive Testing, Professor J. L. Rose listed Wooh as one of the giants in the area of guided waves during the period 1970–2000.

In becoming an associate editor of *Water Resources Research*, a premier journal on hydrology, Professor Daniele Veneziano may no longer be recognizable by his former colleagues in structural engineering. Extending his expertise on statistical theories, he is now concentrating on stochastic and mutifractal analyses of rainfalls and subsurface flows. He was co-organizer of a 2003 symposium on hydrofracals and convenor of a special session on fractal methods in hydrology in the annual European Geophysical Society meeting in France.

Environmental Systems Group

Under the direction of Dr. Eric Adams, the master's of engineering program continues to flourish. The incoming class of September 2002 is projected to exceed 70. Adams was also chief scientist on the summer 2002 field experiment to explore the physical, chemical and biological changes associated with the direct injection of carbon dioxide into the ocean. With support from the Cambridge-MIT Initiative, Dr. Adams is helping to establish an MPhil program at Cambridge University with offerings covering

sustainability of water resources, sensing and control of buildings and e-commerce business development. At the beginning of the fall semester he received a special department award recognizing his contributions to the MEng program.

Though on sabbatical, Professor Rafael Bras played a pivotal role in promoting the Earth Systems Initiative and Terrascope. He also chaired the NASA Earth Sciences and Applications advisory committee, and serves as a member of the advisory committee for NASA. In addition to his election to the National Academy of Engineering, he was elected president of American Geophysical Union's hydrology section. To the department he continues his contributions in fundraising, one of which is the Donald and Martha Harleman Professorship. He also completed an agreement with Prentice-Hall for a book series on civil and environmental engineering. As the next chair of the Faculty, Professor Bras's leadership talent will be tapped again by MIT.

After a year of tireless work, Professor Penny Chisholm led a search committee of seven colleagues and succeeded in recruiting Professor Patrick Jaillet as the new department head. The visionary work led by her and by Professor Bras on the Earth Systems Initiative is bearing fruits as Terrascope is launched. Forty students have preregistered. *Prochlorococcus marinus*, the particularly tiny phytoplankton discovered 15 years ago by Professor Chisholm, then at Parsons Lab, was one of several featured microbes in the June issue of *Natural History* magazine.

Professor Elfatih Eltahir has achieved significant progress towards understanding the role of oil moisture conditions in shaping the summer climate of North America. He has achieved similar progress in the development of a new class of land surface models that includes explicit representation of ground water aquifers. He is also starting a project on the impact of desertification in Dhogar. The results have implications on environmental problems ranging from sustainability of water resources and assessment of environmental impact due to human inuded land cove change to the predictability of droughts and floods at the regional scale.

Professor Dara Entekhabi is leading a multi-institution and multi-million dollar proposal for the development of a satellite to NASA's explorer program. It aims to provide the first global view of the earth's changing soil moisture and surface freeze/thaw conditions. Passive and active microwave measurements will be combined to investigate variations in the water cycle and its effect in terrestrial ecosystems. The system will enable new hydrologic applications and new scientific studies of global change and atmospheric predictability.

In charge of our 1-E program which serves nearly half of our undergraduates, Professor Philip Gschwend led the preparation for this year's visit by ABET on Environmental Engineering. He is close to completing the second edition of his popular text on *Environmental Organic Chemistry*, first published in 2003.

The Civil Engineering Department at Pennsylvania State University has just established the annual Donald Harleman Environmental Fluid Mechanics Lecture. Professor Emeritus Harleman gave the inaugural talk last fall on the engineering, cultural and political efforts to save Venice from steadily rising sea levels by erecting a series of movable gates to be raised and lowered in response to storms.

In a project on arsenic poisoning of drinking water in Bangladesh, Professor Charles Harvey has conducted field and laboratory experiments that provide evidence for the geochemical and hydrologic conditions that cause very high arsenic concentrations. He showed that arsenic is mobilized by reduction and adsorbed after oxidation, and that irrigation pumping may help create condition that mobilize arsenic.

Many years of fruitful research on the Aberjona Project, Professor Harry Hemond is now poised to publish a number of articles, which compare the relative roles of toxicity, and physical habitat alteration as impacts on aquatic life. The study will also compare human impacts on watersheds in Aberjona with those in Tokyo, Switzerland and Brazil.

For his seminal research in coastal engineering, Professor Ole Madsen was presented by American Society of Civil Engineers the 2001 International Coastal Engineering Award. He was further recognized by Army Corps of Engineers through a three-year grant to develop a predictive model for sediment transport along beaches.

With five colleagues from CEE (Dara Entekhabi), EAPS and EECS, Professor Dennis McLaughlin led the Interdisciplinary Initiative on Environmental Data Assimilation, which has been funded by NSF's Information Technology program for five years at $5 million. This endowment and his other grants from NSF and NASA put him in an enviable position to work on the interfaces of hydrology, meteorology and oceanography, and to complement the Earth System Initiative.

Professor Chiang C. Mei became the first holder of the new Donald and Martha Harleman Professorship in July. One of Mei's new research highlights is the effect of random seabed on the propagation of ocean waves. He and students have developed an effective method to predict the attenuation of waves by multiple scattering, a phenomenon similar to Anderson localization in modern physics. His group is studying further the combined effects of nonlinearity and localization. As a practical application of theoretical hydrodynamics, two of his students are developing

numerical models to help the design of the mobile storm gates for the protection of Venice, Italy. In the spring Mei was a member of an international committee to review mathematics research in Norwegian Universities. He also served as the interim department head during 2001–2002.

As the newest pride of CEE department, the Institute named Professor Heidi Nepf a McVicar Fellow for her splendid teaching. Her unique research on vegetation hydrodynamics has attracted wide attention in Europe, Australia, and Canada, in addition to the US. She was invited as a special lecturer at this year's annual meeting of the American Society of Limnology and Oceanography.

The group of Professor Martin Polz is playing a leading role in the quest to understand the diversity of unculturable bacteria, which make up over 99 percent of the environmental microorganisms. In collaboration with nuclear engineers, Polz has found that metal-reducing bacteria are likely capable of fractionating uranium isotopes, which has implication on plutonium reduction. He and Professor Franz Ulm are exploring the bacterial dissolution and hence decontamination of concrete.

Professor Tina Voelker is gaining new grounds in her work on metal complexation reactions. She has received new funding to study copper binding compounds in fresh and coastal waters. She and graduate student Megan Kogut, have completed a study of how copper binds up with humic substances—the tea colored organic material found in soil and rivers and coastal waters

Student Awards

Andrew P. Armacost, a PhD student of Professor Barnhart, received the George B. Dantzig Dissertation Prize and the INFORMS Transportation Science Section Dissertation Prize. Recent CEE grads Joan Walker SM '94 and PhD '01 and Jon Bottom SB, SM '96 and PhD '00 were awarded first and second place honors, respectively, by the Transportation Science Section of the Institute for Operations and the Management Sciences (INFORMS) for their doctoral theses.

Graduate student Song Gao received the UPS doctoral fellowship award.

Our MEng students are also garnishing awards. In the annual MIT $1K entrepreneurial competition, a chlorine generation plan won the tip prize. The CEE project is built upon an SM thesis by Nadine van Zyl MEng '01,"Sodium Hypochlorite Generation for Household Water Disaffection in Haiti." MEng student Luca Morganti provided background details. The business plan was developed and will be implemented by a multi disciplinary team of MIT students from Sloan School, Chemical Engineering, Economics, Media Lab, and Mechanical Engineering. Senior Lecturer Susan Murcott of Parsons Laboratory is the faculty advisor.

Senior Yanni Tsipis '01 published his second book, *Building of the Massachusetts Turnpike*, that chronicles the construction from 1954-1965. His first book was on the central artery.

A PhD student of Professor Simchi-Levi, Mr. Yao Zhao has recently been awarded an honorable mention in the 2001 MSOM student paper competition for the paper "The Value of Information Sharing in a Two-stage Supply Chain with Production Capacity Constraints: The Infinite Horizon Case"

At the annual CEE senior recognition dinner on June 5, Sandi Lin '02 received the Steinberg prize for academic achievement and demonstrable interest in construction management. Lin, Matthew Van Horne, and Daniel Feldman shared the Richard Lee Russel awards. The Leo '24 and Mary Grossman award for an undergraduate with a strong interest in transportation and a strong academic record was given to Isaac Moses '02.

At the first IDEAS design competition on May 9, 2002, sponsored by the d'Aberloff Foundation, the Edgerton Center and the Service Learning Center, two students of Senior Lecturer Susan Murcott took the two top prizes, one for a water filter project in Nicaragua (Rebecca Hwang, MEng) and the other for an arsenic filter for Nepal, Bangladesh, and India.

The $5,000 Lemelson International Technology Award went to Innovative Drinking Water Technology for Bangladesh, West Bengal and Nepal, a project by graduate students Tommy Ngai and Heather Lukacs, and Debu Sen, cofounder of iDL Systems Inc.

Daniel Collins, a PhD student under Professor Rafael Bras, received an Outstanding Student Paper award for his poster presentation at the AGU meeting last December in San Francisco. The poster described "Meta-stable Vegetation Cover and Erosion Cycles."

As the winner of Switzer Foundation environmental fellowship, graduate student Janelle Thompson will study the link between the deterioration of coastal environments through anthropogenic pollution and the increase in growth of pathogenic microorganisms.

Ralph Hall, student of Professor Joe Sussman, and Natalia Ramirez, student of Professor Richard de Neufville, shared the Technology and Policy Program award for best thesis.

This year the Tucker-Voss award goes to Benjamin Cheatham, a graduate student in construction engineering and management.

The department presented three special recognition awards, all for outstanding service to the department plus something extra. Graduate student Yo Ming Hsieh was honored "in particular to making computers user-friendly to all of us."

The 2001 Effective Teaching Assistant awards went to Steve Margulis for an undergraduate subject (1.070 Introduction to Hydrology), and Kristen Jellison for a graduate subject (1.725 Chemicals in the Environment).

Personnel

As of August 1, 2002, the department will be headed by Professor Patrick Jaillet, who came from University of Texas/Austin where he was chair of the Management and Information Sciences Department in the School of Business. He is an expert in operations research and transportation systems.

Chiang C. Mei
Acting Department Head
Donald and Martha Harleman Professor
Professor of Civil and Environmental Engineering

More information about the Department of Civil and Environmental Engineering can be found on the web at http://web.mit.edu/civenv/.

Department of Electrical Engineering and Computer Science

This academic year, as the department now known as Electrical Engineering and Computer Science (EECS) celebrates its 100th anniversary, we "look back to the future." As such, we reflect on 100 years of history and progress and speculate our further evolution.

Our strategic plan has been two-fold: looking for innovative ways to use technology, including working across departmental lines, and continuing to hire and retain the best faculty possible. This includes hiring faculty jointly with other units at MIT.

Within this plan, the department is committed to increasing the number of women in our faculty and student ranks. As one means to that end, this year saw the inauguration of a new summer program, the Women's Technology Program (WTP) under the direction of Douglas Ricket, a graduate student at MIT. Over 220 applications were received from high school students around the country to fill only 25 spots. For four weeks, these young women explored topics in electrical engineering and computer science, focusing on engaging hands-on experiments and projects interspersed with lectures in electrical engineering, computer science, and math. They also took advantage of the opportunity to explore the MIT community and the surrounding areas in their free time. It was apparent at the final banquet that the program was an enormous success and that these students surprised not only themselves, but also their instructors, with their accomplishments.

Progress continues on the construction of the Stata Center and our excitement builds daily as we grow nearer to the completion date in the fall of 2003. A Topping Off ceremony was held on June 24, 2002. This ceremony is traditionally held whenever a building's final steel element is put into place. The beam is generally autographed by all project team members and labor trades before being hoisted into place: a celebration follows to honor the hard work of the workers. Our ceremony differed in that the Stata Center is a concrete structure, so instead of a steel beam, a concrete bucket was lifted to signify that the final concrete tower has been placed. In keeping with traditional topping-off customs, the bucket was decorated with an American flag and evergreen tree and workers autographed a commemorative sign (in lieu of the beam), which will later be featured on the construction site.

For 100 years the members of this department have strived for and often reached greatness. What does the next 100 years hold for EECS? Only time will tell. However, we know that our faculty, students, and staff are certainly up to the challenge.

Undergraduate Program

Enrollment of undergraduates averaged 815 in 2001-2002, close to that of 2000-2001, with 13 percent in the Electrical Engineering Program (6-1), 31 percent in the Computer Science Program (6-3), and 56 percent in the Electrical Engineering and Computer Science Program (6-2). From the Class of 2004, 320 students were enrolled in Course VI. About 279 students from the Class of 2005 have so far selected Course VI, with 17 percent choosing 6-1, 50 percent choosing 6-2, and 33 percent choosing 6-3.

The Master of Engineering (MEng) program entered its eighth year with 185 students.

The following prizes and awards were won by our students. The David A. Chanen Writing Award was awarded to Marion Jones. The Robert A. Fano UROP Award was given to Eric Hsieh and Prasad Ramanan. The George C. Newton Prizes for the best undergraduate laboratory projects were awarded to Sourav Dey and Manu Seth. The Northern Telecom/BNR Project Awards were made to Nathan Fitzgerald, Andrew Lamb, Christopher Lyon, David Milliner, Yonathan Nutam and Edward Hill. The Nylander Award for an advanced undergraduate project was awarded to Yoan Anguiet and Matthew Mishrikey, with honorable mentions going to Winston Chang, Aneal Krishnan, Andrew Lamb, and Peter Russo. The Ann Pogosyants Undergraduate Research Opportunities Program (UROP) Award was given to Christopher Luhrs.

Graduate Program

In September 2001, there were 853 graduate students enrolled in the department. About 26 percent of the total were foreign nationals. The department supported 537 research assistants and 110 teaching assistants. In addition, there were 163 fellowships including 27 National Science Foundation fellows and 12 Department of Defense fellows. The remaining students had industrial or foreign support or were using their own funds.

During 2001, the department awarded 87 master of science degrees, two electrical engineer degrees and 84 doctoral degrees.

The department received 2,243 applications for the 2001–2002 year, a slight decrease from 2000. The applications continue to be generally excellent and 276 were admitted for 2001, February, June, and September, of whom 137 registered in September.

A number of awards were made to graduate students for excellence in teaching. Benjamin Vandiver received the Carlton E. Tucker Award and Watjana Lilaonitkul received the Harold L. Hazen Award. The Frederick C. Hennie III Awards for excellence in teaching were presented to Brian Dean, David Dunmeyer, and Kazutaka Takahashi. The David Adler Memorial Thesis Prize was shared by Eko Lisuwndi and Esa Masood, with honorable mention going to Rajul Shah. The Ernest A. Guillemin thesis

competition for outstanding performance on a master of engineering thesis in electrical engineering was won by Petros Boufounos and Joseph Levine, with an honorable mention to Chi Yu Liang. The Charles and Jennifer Johnson theses prizes for outstanding performance on master of engineering thesis in computer science went to Jeremy Nimmer and Heidi Pan. The Morris Joseph Levin Awards for best masterworks oral theses presentations were awarded to Todd Coleman, Lillian Dai, Joseph Levine, Ari Libarikian, Michael Mills, Allen Miu, Delphine Nain, Adam Rosenthal, and David D. Wentzloff. The William A. Martin Memorial Thesis Prize for outstanding performance on a master of engineering thesis in computer science was presented to Frank Dabek and Delphine Nain, with honorable mentions going to Andrej Bogdanov, Alex Park, and William Thies. The George M. Sprowls Awards for outstanding research contributions in the field of electronic computer and investigation research went to Miguel Castro '01 (Microsoft Research Ltd.), Edward Kohler '01, and Matthew Antone '01. Departmental Special Recognition Awards were presented to Maya Said and Sanjay Rao.

VI-A Internship Program

The department's VI-A internship program is in its 85th year. Last year substantial changes to the VI-A requirements were made to maximize flexibility for students by allowing easy entrance and exit at any time. In addition, there was a new fall VI-A recruitment for seniors who wanted to do an industry-based master of engineering thesis. However, this fall recruitment process resulted in only one new student joining the program. This year, 144 students applied during the annual orientation and selection process and 26 were selected as members of the incoming VI-A class. To compare, in 2001, 108 students applied and 42 were selected, while in 2000, 73 students applied and 41 were selected. Since the last report, approximately 14 students have withdrawn from the VI-A internship program as they felt their needs were better matched with opportunities available on-campus. However, most VI-A students find this program professionally rewarding and a source of satisfaction. Emphasis is made to ensure that the participating companies continue to offer challenging and well-supervised assignments.

No new companies joined VI-A this year and due to the poor economy, many companies did not participate in the annual orientation and selection process. However, these companies are continuing with the students already in the program and many of them have indicted an interest in resuming their active participation in the future.

In June, 22 VI-A students received the MEng degree having completed all their company assignments and Institute degree requirements. There were 24 VI-A students who were awarded their bachelor's degree and most of them will continue into the graduate phase of the program.

Many honors and awards continue to be bestowed on VI-A students. Eko Lisuwandi (Linear Technology Corp.) was selected a Siebel Scholar, which recognizes students who have demonstrated academic and leadership excellence.

Bradley P. Ginsburg (Analog Devices) was the recipient of the second prize for the best undergraduate essay by the History Faculty.

This year marked the first year of the IDEAS competition, a design competition targeted at innovations that help the community. Two VI-A students, Arthur Musah (Texas Instruments) and Regina Sam (IBM Corporation) were among the recipients of the IDEAS Prize.

At the annual department social and awards ceremony held at the Museum of Fine Arts in Boston, the following VI-A students were honored: Sean Lie (Silicon Graphics) received a George C. Newton Undergraduate Laboratory Prize for the best 6.111 project; Eko Lisuwandi (Linear Technology Corporation) won the David Adler Memorial Thesis Prize for the best master's thesis in electrical engineering; and Rajul Shah (IBM Corporation) won an honorable mention.

Academic excellence ranks high in the VI-A program as 12 students were initiated into Eta Kappa Nu, the Electrical Engineering National Honor Society, and 11 students were initiated into Tau Beta Pi, the National Engineering Honorary Society.

Most significantly, long-time VI-A administrator Lydia O. Wereminski received the College of Engineering Infinite Mile Award for excellence in April, 2002 for her 45 years of excellent service to EECS, including the VI-A program since 1969. In addition, effective July, 2002, Lydia will begin her well-deserved retirement from MIT. We wish her the best.

Faculty Notes

Eight new faculty joined the department this year:

- Victor W. Zue, professor of electrical engineering and computer science, who received his ScD from MIT
- William T. Freeman, associate professor of electrical engineering and computer science, who received his PhD from MIT
- Frans X. Kaertner, associate professor of electrical engineering and computer science, who received his PhD from Technical University of Munich
- Bruce Tidor, associate professor of chemistry and biological engineering, who received his PhD from Harvard University
- Marc A. Baldo, assistant professor of electrical engineering and computer science, who received his PhD from Princeton University

- Erik D. Demaine, assistant professor of electrical engineering and computer science, who received his PhD from the University of Waterloo
- David J. Perreault, assistant professor of computer science and engineering, who received his PhD from MIT
- Michael H. Perrot, assistant professor of electrical engineering and computer science, who received his PhD from MIT
- Jovan Popovic, assistant professor of electrical engineering and computer science, who received his PhD from Carnegie Mellon University

There were three promotions in the department. Associate professors Frans Kaertner and Bruce Tidor, and Professor Victor Zue were all granted tenure.

Professors Arvind, Munther Dahleh, Clifford Fonstad, Shafrira Goldwasser, Berthold Horn, Erich Ippen, M. Frans Kaashoek, Silvio Micali, John Tsitsiklis, George Verghese, and Jacob White, and associate professors Duane Boning, Anantha Chandrakasan, Peter Hagelstein, and David Karger were on sabbatical for all or part of the year.

There were three administrative appointments this year: Professor Eric Grimson was appointed education officer; Professor Barbara Liskov was appointed associate department head, replacing Professor Tomás Lozano-Pérez; and Professor Victor Zue was appointed director of LCS.

The department hosted three visiting faculty this year: Professor Katrin Kneipp, associate professor Kenneth O, and professor of the practice Gregory Papadopoulos.

Professors Fred Hennie, Steven Senturia and Arthur Smith retired from the faculty. Associate professors Julie Dorsey and Vahid Tarokh resigned from the faculty. We are saddened by the passing of Professor Peter Elias and Professor Michael L. Dertouzos.

Faculty Awards and Honors

Professor Dimitri Antoniadis received the 2002 IEEE Andrew S. Grove Award. Professor Arvind was honored with the distinguished alumnus award from the University of Minnesota. Professor Krste Asanovic was appointed the Jamieson Career Development Professorship. Professor Hari Balakrishnan received the Junior Bose Award for excellence in teaching. He was also awarded the Alfred P. Sloan Foundation Fellowship. Senior research scientist David Clark was elected to the American Academy of Arts and Sciences. Professor Jesus del Alamo received the Bose Award for excellence in teaching. Professor Mildred Dresselhaus was honored with the Medal of Achievement in carbon science and technology from the American Carbon Society. Professor James Fujimoto was one of the co-recipients of the 2002 Rank Prize in opto-electronics. Professor Paul Gray received the MLK Faculty Achievement Award. Professor Berthold Horn was elected to the National Academy of Engineering. Professor Piotr Indyk received the National Science Foundation Career Award 2001. Professor James Kirtley was awarded the 2002 IEEE Nikola Tesla Award. He was also elected to the American Academy of Arts and Sciences. Professor Richard Larson was awarded the Sir Edward Youde Memorial Fund Visiting Professorship. Professor Tomás Lozano-Pérez was appointed to the TIBCO Founder's Chair. Professor Muriel Médard was appointed to the Edgerton Career Development Chair. Professor Joel Moses was named Chancellor's Distinguished Lecturer at Louisiana State University. Professor David Perreault received the ONR Young Investigator Award. Professor Rajeev Ram was appointed to the ITT Professorship. He was also awarded the Ruth and Joel Spira Award for distinguished teaching. Professor Rahul Sarpeshkar received the 2001 Packard Fellow Award in science and engineering. Professor Gerald Jay Sussman was elected to the IEEE. Professor Vahid Tarokh was recognized as one of the "Top 100 Inventors of the Year" by *Technology Review* magazine. Professor John Tucker received the Distinguished Service Award for 2000 presented by the Eta Kappa Nu Association.

John V. Guttag
Department Head
Professor of Computer Science and Engineering

More information about the Department of Electrical Engineering and Computer Science can be found on the web at http://www.eecs.mit.edu/.

Department of Materials Science and Engineering

The Department of Materials Science and Engineering (DMSE) has maintained its intellectual and educational leadership. Department faculty and students continue to be honored with prestigious awards and medals from various professional societies and international organizations. Renovations and modernization of many of our facilities continue; the renovated spaces include laboratories, faculty and student offices, and administrative space, and all will be discussed later in this document. A single department faculty search committee was active during the year seeking to fill two positions, one in micro/nano-scale processing and properties of materials, and a broader search for an outstanding individual in any area of materials science and engineering. An active period of interviews in the spring semester concluded with DMSE extending two offers to potential assistant professors, both of which were accepted. As a result of this and previous searches, Professors Angela Belcher, Randolph E. Kirchain, Christopher A. Schuh, Francesco Stellacci, and Krystyn J. Van Vliet will be joining our faculty and a brief description of their backgrounds can be found in the following pages.

Our total enrollment stands at approximately 300 students. Our undergraduate program was evaluated by the Accreditation Board for Engineering and Technology in fall 2001 and was fully re-accredited. An initiative to rebuild our undergraduate program is underway. June 2002 saw the first graduates of our new master of engineering program; one of the graduates will begin studies in our master of science program this fall while the others have pursued employment.

Faculty members from the department continue significant involvement with major Institute initiatives. Professor Edwin Thomas heads the new Institute for Soldier NanoTechnology (ISN). Professor Lionel Kimerling continues to lead the Materials Processing Center and the Microphotonics Center. Professor Michael Rubner serves as the director of the Center for Materials Science and Engineering, which is funded by the National Science Foundation as a Materials Research Science and Engineering Center. Six department faculty members are affiliated with the Singapore-MIT Alliance and Professor Carl Thompson is the MIT co-chair of the Advanced Materials for Micro- and Nano-Systems Program. The Cambridge-MIT Institute, a global alliance with Cambridge University, is directed at MIT by Professor John B. Vander Sande. The Lemelson-MIT Program is directed by Professor Merton C. Flemings.

Renovations

In March of this year, DMSE opened a new nanomechanical technology laboratory, equipped with state-of-the-art instruments for the study of the mechanical properties of surfaces and devices at the atomic and molecular scale. This lab is the most prominent and visible laboratory along MIT's Infinite Corridor and its glass walls and plasma screen displays of educational and research information inform passersby of its activities.

The laboratory will have unique capabilities for studying the properties of the tiny world and will be home to the Institute's first nanoindenters, machines that probe and measure the properties of surfaces of engineering and biological materials. Faculty from DMSE with research and teaching ties to the "NanoLab" are Professors Lorna Gibson, Klavs Jensen (joint appointment with Chemical Engineering), Nicola Marzari, Christine Ortiz, Subra Suresh, Edwin Thomas, Carl Thompson, Sidney Yip (joint appointment with Nuclear Engineering) and new faculty members Angela Belcher (joint appointment with Biological Engineering) and Christopher Schuh; from Electrical Engineering and Computer Science are Professors Jesus del Alamo and Martin Schmidt; from Mechanical Engineering, Professor Lallit Anand; from the Biological Engineering Division, Professor Ram Sasisekharan; from Aeronautics and Astronautics, Mark Spearing; and from Chemical Engineering, Professor Jackie Ying.

The NanoLab is also expected to play an important role in the activities of the ISN. In addition to research, the lab also will be key to a number of educational activities; lab components will be added to a variety of DMSE subjects and preliminary plans are under way to link the NanoLab to the WebLab, the online microelectronics lab developed by del Alamo.

The NanoLab was made possible by a combined donation of $500,000 from Harold Hindman (SB '39 chemistry; SM mechanical engineering) and George Burr (SB '41 physics), cofounders of Instron Corporation; a pledge of $500,000 in cash and equipment from Instron Corporation itself; and an equipment grant of $500,000 from the Office of Naval Research to purchase the nanoindenter. Additional funding came from the Institute and the Lord Foundation of Massachusetts Inc.

Several ongoing construction projects were completed in September 2001. A 700 sq. ft. state-of-the-art distance learning classroom, funded by and shared with CMI and SMA, seats up to 25; it was completed and actively used through this past academic year. Space for SMA and CMI Headquarters, containing offices for directors and primary staff, was completed and occupied. This space is loaned by DMSE for a period of five years in exchange for the space renovation. A DMSE Graduate Student Lounge containing a kitchenette, seating areas, Athena terminals, and a facility for rehearsing presentations was completed and sees active use. A 950 sq. ft. student office in the basement of Building 8 was renovated to provide space for 24 incoming graduate students.

A biomaterials research laboratory was completed in March 2002 for Assistant Professor Darrell Irvine. The 900 sq. ft. facility in Building 8 includes space for tissue culture and characterization.

Research Initiatives

As noted earlier, MIT learned this spring that the Army had selected its proposal for an ISN. The Army has funded this project for five years for $50 million, to which industry will contribute an additional $40 million in funds and equipment. DMSE's Professor Edwin L. Thomas will direct the ISN in creating lightweight molecular materials to equip foot soldiers of the future with uniforms and gear that can heal them, shield them, and protect them against chemical and biological warfare. The ISN will have approximately 150 staff, including 35 MIT professors from nine departments in the schools of Engineering, Science, and Architecture and Planning. In addition to personnel from MIT, the ISN will also include specialists from the Army, E.I. du Pont de Nemours and Co.; Raytheon Co.; and physicians from Massachusetts General Hospital and Brigham and Women's Hospital. The ISN will focus on six key soldier capabilities: threat detection, threat neutralization (such as bullet-proof clothing), concealment, enhanced human performance, real-time automated medical treatment, and reduced logistical footprint (i.e., lightening the considerable weight load of the fully equipped soldier).

Undergraduate Education

Our undergraduate enrollment stands at about 101 students and currently includes 65 percent women, 15 percent underrepresented minorities, and 5 percent international students. We continue extensive recruiting efforts to maintain our undergraduate student body, including participation in academic expo during freshman orientation, an open house, the annual John Wulff Lecture, direct mailings to the freshman class, freshman advisor seminars, and IAP activities. Our III–B internship program continues to attract the majority of DMSE undergraduates; 41 DMSE students were placed at more than 20 host institutions during the summer of 2002, including three overseas institutions.

Professor Lorna Gibson and Professor Linn Hobbs acted as faculty advisors for the department's undergraduate exchange program with Cambridge University as part of the CMI exchange. One DMSE student and two Cambridge University materials students participated in the exchange with the Department of Materials Science and Metallurgy at Cambridge University. Next year, we anticipate that four DMSE students and three Cambridge students will be participating in the department's CMI exchange program. In addition, Professor Gibson collaborated with colleagues at Cambridge University who teach a short course on materials selection and design to enable MIT students to take the subject via distance learning over IAP.

DMSE faculty have begun a major initiative to redesign the current undergraduate curriculum, which has been in place for nearly two decades with only incremental changes. Professor Sadoway is leading this effort. Major goals of the new curriculum will be integration of lecture and laboratory learning modules; introduction of topics on a "need-to-know" basis; introduction of a mathematics subject that will run throughout the sophomore year and be taught by DMSE faculty to support core subjects in DMSE; increased collaborative teaching efforts for student and faculty enrichment; and increased opportunities for student/faculty interaction. Eight faculty working groups have been designated to develop curricular offerings in these areas: thermodynamics and structure; physical chemistry and structure; mechanical behavior; electronic, photonic, and magnetic properties; organic materials chemistry; inorganic materials chemistry; materials processing and product design; and conceiving, designing, implementing and operating materials systems. Concurrent related activities are developing laboratory modules and designing facilities to accommodate them; a new laboratory facility for undergraduate education is currently being designed, and it will be located along the infinite corridor in Building 8. DMSE plans to offer the new curriculum to the sophomore class in 2003.

Graduate Education

The department has a very healthy graduate student enrollment—188 in fall 2001. Approximately 29 percent of our graduate students are women and 3 percent are underrepresented minorities.

Two of our students were enrolled in the Technology and Policy Program (TPP) and three were enrolled in the Leaders for Manufacturing Program (LFM). Twenty-one of our students were enrolled in the program for Polymer Science and Technology (PPST). We anticipate for the fall of 2002 a total graduate student enrollment of about 220. We will register an incoming class of 74 for the coming fall, over 60 percent of whom are domestic.

Our continuing work to expand offers of one- and two-semester fellowships to a large percent of domestic applicants has been successful. Nearly all undesignated gifts to the department are currently being used to fund endowed fellowships (including the Nicholas J. Grant fellowship, the John F. Elliott fellowship, the Ronald A. Kurtz fellowship, the Gilbert Y. Chin fellowship, the R.L. Coble fellowship, the Carl M. Loeb fellowship, the David V. Ragone fellowship, the H.H. Uhlig graduate fellowship, the Stuart Z. Uram fellowship, the Class of '39 fellowship, and the department endowed fellowship). Our endowed fellowships now provide sufficient annual income for one-semester fellowships for approximately 28 students.

In addition to the above, we are grateful recipients of a number of grants from corporations and foundations, including the Whitaker Foundation, Draper Laboratories, Dupont, Lucent Technologies, the Semiconductor Research Corporation, and the Hertz Foundation. In addition, many students have other outside fellowship support; of the 44 domestic students expected to enter in the fall of 2002, 39 will be entering on fellowships from the department, the Institute, the NSF, and the Department of Defense.

The incoming graduate students in September 2001 were the first students to enter our new doctoral programs. The new academic programs are bio- and polymeric materials, chaired by Professor Mayes; electronic, photonic, and magnetic materials, chaired by Professor Ross; emerging and fundamental studies in materials, chaired by Professor Ceder; Structural and environmental materials, chaired by Professor Flemings. In addition, DMSE continues to offer the doctoral program in archaeological materials.

The department continued its program of invited lectures by distinguished researchers in the field of materials science and engineering. Professor Ilhan A. Aksay of the Department of Chemical Engineering at Princeton University spoke on "The Role of Biology in the Development of New Materials." The lecture was supported by the Singapore-MIT Alliance Advanced Materials for Micro- and Nano-Systems Program and drew an audience from inside and outside our department.

Master of Engineering Degree in Materials

This program saw its first graduates this June and its second incoming class of eight students began their classwork in June 2002. Interest in the program is growing though its tuition cost continues to discourage applicants. Students in the program take two graduate classes in the summer, one of which will be partially taught in parallel with the SMA MEng program during the period in which students from Singapore are in residence at MIT. They also take a seminar subject that includes talks given by Professor Carl Thompson, "Engineering of Polycrystalline Films for Applications in Micro-and Nano-Systems"; Professor Rajeev Ram (EECS), "Components and Materials for Optical Communications"; Professor Edwin Thomas, "Morphological Control and Supramolecular Engineering of Polymeric Based Systems"; and Professor Darrell Irvine, "Biomaterials for Immune System Bioengineering."

Other Educational Initiatives

With support from the NSF, four DMSE faculty (Professors Allen, Hobbs, Hosler, and Lechtman) launched a Summer Institute in Materials Science and Material Culture (SIMSMC) with an inaugural group of 12 students in residence for two weeks in June 2002. The participants were faculty members from liberal arts colleges around the country, representing fields from art history to physics. The summer institute aims to encourage and assist faculty at liberal arts colleges in introducing materials science and engineering to their undergraduate curricula, and uses archaeological science as a vehicle for accomplishing this goal. The summer institute philosophy is grounded in principles our faculty considers fundamental to the design of higher education in the 21st century: that science and engineering have their origins in multiple cultural traditions which account for their richness and permanence as human endeavors; and that access to the social wealth of society lies in education that allows people to generate and interpret a wide range of data from a broad methodological base. The June 2002 program included one-week modules on "Building Bricks and Monumental Glue," coordinated by Professor Hobbs, and "The Power of Metal in the Ancient Andean World," coordinated by Professor Lechtman.

Student Organizations

Officers of the Society of Undergraduate Materials Students (SUMS) for 2002–2003 will be Lauren Frick, president; Yihvan Vuong, vice-president; Catherine Tweedie, secretary; and Allon Hochbaum, treasurer.

The Graduate Materials Council (GMC) officers for 2002–2003 will be Douglas Cannon, president; Marc Richard, vice president; Raul Martinez, treasurer; Bo Zhou, Daniel Sparacin, and Ryan Williams, social chairs; Joseph Bullard, athletic chair; Garry Maskaly and David Danielson, representatives to the Departmental Committee on Graduate Students (DCGS); Ashley Predith and Chris Musso, representatives to the Graduate Student Council (GSC).

Personnel

We are pleased to announce that Angela Belcher, Randolph E. Kirchain, Christopher A. Schuh, and Francesco Stellacci will be joining our faculty this fall. Most recently, Professor Belcher has been a faculty member in the Department of Chemistry at the University of Texas at Austin. She will be the John Chipman career development associate professor of materials science and engineering in our department and the Biological Engineering Division. She holds a PhD in chemistry from the University of California at Santa Barbara. Professor Kirchain will be assistant professor of materials science and engineering. Previously, he was assistant director of the Materials Systems Laboratory at MIT. Professor Kirchain holds a PhD from our department. Professor Schuh will be assistant professor of materials science and engineering; Professor Schuh was most recently at Lawrence Livermore Laboratories and holds a PhD from Northwestern University. Professor Stellacci will be assistant professor of materials science and engineering. He holds a doctorate in materials science engineering from the Politecnico di Milano and comes to us from the University of Arizona, where he was a postdoctoral researcher working

on three-dimensional optical memories and creation of nanoscale electronic devices.

Krystyn J. Van Vliet has recently accepted a position as assistant professor of materials science and engineering in our department. Professor Van Vliet conducted her doctoral studies in our department. She will pursue postdoctoral research investigating cellular mechanotransduction at a Harvard Medical School–associated facility before joining our ranks in September 2003.

Professor Fred McGarry and Professor August Witt will both retire from the department as of July 1, 2002. Professor McGarry holds an AB in physics and math from Middlebury College and an AB and an SM in mechanical engineering from MIT. He joined our faculty in 1974. He provided great service to the Institute, including serving as secretary of the faculty and director of the summer session. Professor Witt joined the DMSE faculty in 1962 after completing a PhD in physical chemistry at the University of Innsbruck. Professor Witt's teaching of 3.091 Introduction to Solid-State Chemistry is famous; he taught the subject for 20 years, during which time he instructed approximately 10,000 students. Although retired, both Professor McGarry and Professor Witt plan to continue working with the department and with the Institute.

Research Highlights

Research in Professor Allen's group is working to develop transient liquid-metal infiltration processes for fabricating metal parts by three-dimensional printing, and in structural and performance characterization of ferromagnetic shape-memory alloy actuators.

Professor Carter and his students develop a wide range of computational approaches to understand fundamental aspects of microstructure development and their effects on materials properties; recent work on calculating the optical response of dielectric composites has yielded approaches for the design of photonic media.

Professor Ceder's group has developed a theory to study slow fracture under conditions where impurities respond to the changing state of stress and strain.

Professor Chiang and his students have discovered an electrochemically-driven solid-state amorphization process that is important in ultrahigh energy density lithium-metal anodes.

Professor Cima's work focuses on the processing and fabrication of complex ceramic and electronic components via three-dimensional printing and microfabrication/micromolding, biomedical applications and controlled-release drug delivery, and thin-film superconductors.

Professor Clark developed a methodology for extending engineering models to calculate a "life-cycle emissions inventory" that includes data about the volume of chemicals and other materials released and consumed during the lifetime of a product from manufacture through use and disposal.

In Professor Eagar's group, a new method of scaling order-of-magnitude solutions of complex combinations of differential equations has been developed and demonstrated for modeling of welding processes.

Professor Fink's group has developed a new methodology for creating photonic band gap optical fibers which exhibit reflectivity values that rival the best known metal reflectors.

Professor Fitzgerald's group has demonstrated the monolithic integration of room-temperature cw GaAs/AlGaAs lasers on Si substrates via relaxed graded GeSi buffer layers.

Professor Flemings's group developed an innovative method for forming microstructures which can be used directly for semi-solid forming.

Professor Gibson is working with other MIT faculty to find bone substitute materials and on tissue engineering for orthopedic applications.

Professor Hobbs's work on orthopedic joint prosthesis materials has investigated the formation of new bone-opposing hydroxyapatite-coated cementless implants in hip prostheses.

Professor Hosler is engaged with the first phase of a large-scale excavation project at the copper smelting site of El Manchon, Guerrero, the only pre-European copper smelting site yet discovered in the Americas.

Professor Irvine, who joined our faculty this year, has initiated a research program focused on bioengineering of the immune system. One area that has already shown promising initial results is the development of synthetic surfaces that can elicit tailored activation and proliferation of T cells; such devices could be used to generate defined populations of lymphocytes for immunotherapy.

Professor Kimerling's group has developed passivation schemes of silicon wafer surfaces for environmentally benign processing and developed a methoxy surface termination, based on an iodine catalyzed chemistry.

Professor Latanision's group collaborated with colleagues at the Pennsylvania State University to produce reference and pH electrodes that function in high-temperature high-pressure water that will be used to examine dealloying and stress corrosion cracking in supercritical water systems.

Professor Lechtman is engaged in a multi-year research program aimed at documenting and interpreting the development and spread of bronze metallurgical technologies in the Andean culture area during the Middle Horizon period (ca. 600–1000).

Professor Lupis explored the application on Input-Output Models to the optimization of the flow sheets of large metallurgical plants and the impact of regulations on emissions of carbon dioxide and other greenhouse gasses.

Professor Marzari has completed the first studies of chemical reactions on a metal surface with full *ab-initio* molecular dynamics, for cannonball dissociation of Cl_2 on Al (111) and for partial oxidation of methane on the missing-row reconstruction of Pt (110).

Professor Mayes's and Professor Sadoway's groups have collaborated to synthesize new block copolymer electrolytes for the first time by atom transfer radical polymerization and have shown that these electrolytes exhibit mechanical and electrical properties indistinguishable from materials made by the more difficult anionic polymerization method.

Professor McGarry's group is working to improve the fracture toughness of rigid silicone resins.

Dr. O'Handley and his students have studied the effects of strain on magnetic thin-film properties, and also made significant advances in characterizing ferromagnetic shape-memory actuator performance at frequencies up to 1 kHz.

Professor Ortiz's group used high-resolution force spectroscopy to measure the complex intermolecular interaction forces between individual end-grafted Poly(ethylene oxide) chains and a probe tip covalently bound with human serum albumin, the most abundant blood plasma protein in the human body.

Dr. Paul is studying the interaction between two ferromagnetic grains with grain boundary structure in the presence of segregation.

Current research in Professor Powell's group includes modeling of the Electric Field-Enhanced Smelting and Refining of Steel Project, using fluid-flow and phase-field approaches.

Professor Ross's group is studying magnetic random access memories, including understanding magnetization reversal and interactions between small (sub-100 nm) magnetic structures, and magnetoresistance measurements.

Professor Roylance's research has centered on process-structure-property investigations of polymers and composite materials, dealing especially with mechanical properties.

Professor Rubner and his group have devised a number of simple strategies for manipulating electronically active polymers and small-molecule light emitters into thin-film devices such as using layer-by-layer processing to form functionally active polyelectrolyte multilayers.

Professor Russell is studying embryo destruction and injection for understanding nuclear pressure vessel embrittlement and thin-film deposition under ion-beam mixing.

Professor Sadoway's group has designed, constructed, and tested a flexible, thin-film microbattery that has exhibited record-breaking values of energy and power density.

Professor Smith's research has used *in situ* scanning probe microscopy that simultaneously characterizes the evolution of the surface structure and electrochemical properties of Li-ion battery electrodes.

Professor Suresh's group has developed a variety of new theoretical and experimental methods for the analysis and measurement of mechanical and coupled properties of nanostructures, small-volume structures, thin films, and active materials; these new findings were reported in several papers published in *Science* and *Nature*. During the past year, the research groups of Professors Suresh and Yip have also collaborated to develop a new interatomic finite element method for the prediction of defect nucleation at surfaces and for modeling the nanomechanics of deformation in materials

Professor Thomas's group has used directional solidification and epitaxy to obtain precise control of nanopatterns in block copolymer microdomains.

Professor Thompson and his students have characterized the reliability of new Cu-based integrated circuit interconnects and shown that there are significant differences from Al-based interconnects, requiring new layout and reliability assessment methodologies.

Professor Tuller's group has investigated the feasibility of operating resonant bulk acoustic wave devices at elevated temperatures, holding promise for providing means for *in situ* monitoring of physical and chemical deposition processes.

Professor Vander Sande's group is studying the physical chemistry of the oxidation process by which fullerenic nanotubes have been produced from oxidation of SiC.

Professor Witt's group conducted solidification experiments to optimize the design of a crystal growth research facility for the International Space Station.

Professor Wuensch's group is studying the crystal chemistry and electrical properties of a pyrochlore with composition $Bi_3Zn_2Sb_3O_{14}$ which has dielectric properties that are attractive for use in capacitors.

Professor Yip's group continues research on multiscale modeling with emphasis on mechanical and thermal behavior in metals, semiconductors, and ceramics.

Awards and Honors

Last December, Professor Thomas W. Eagar presented the General Electric Distinguished Lecture at the invitation of the Materials Science and Engineering Department at Rensselaer Polytechnic Institute; the title of his lecture was "Advanced Materials: Steel to Buckyballs—So Where Do We Go From Here? Or, Should You Believe What You Read in the News?" Professor Eagar was among the MIT employees welcomed into the Quarter Century Club. Professor Linn Hobbs received the 2002 Arthur C. Smith Award for "sustained notable contributions to the undergraduate program at MIT." For fundamental contributions to multi-scale chemical reaction engineering with important applications in microelectronic materials processing and microreactor technology, Professor Klavs Jensen was welcomed into membership of the National Academy of Engineering. Professor Christine Ortiz received a Presidential Early Career Award for Scientists and Engineers; the NSF was her sponsoring organization and the award will be presented at the White House in Washington, DC, this fall. Professor Subra Suresh was also awarded NAE membership; his citation recognized him for "development of mechanical behavior theory and experiment for advanced materials and applications, and for demonstrating fruitful new avenues for structural study." Professor Harry Tuller presented an invited lecture in the "Faculty of Science Public Lecture Series" at Victoria University, Wellington, New Zealand; his lecture was entitled "Promise of Materials Science in the 21st Century." Professor Tuller was elected to serve as a councilor of the International Society of Solid State Ionics for 2002–2003. Professor Claude Lupis was named an ASM fellow; the citation reads, "for seminal contributions to the application of thermodynamic principles to chemical metallurgy, and for the development of economic analysis for large-scale metallurgical systems."

Robert C. O'Handley, a DMSE senior researcher, gave an invited talk on Ferromagnetic Shape Memory Alloys at the March meeting of the American Physical Society in Indianapolis. Dr. O'Handley's textbook *Modern Magnetic Materials, Principles and Applications* (John Wiley and Sons, New York, 2000) will soon go into its fourth printing and is scheduled to be translated for sale in China.

John W. Cahn, a former DMSE faculty member currently on the staff of the National Institute of Science and Technology, received the 2002 Bower award and prize for achievement in science, a high honor given by the Franklin Institute in Philadelphia. Dr. Cahn's contributions to the field of physical metallurgy are numerous and widely recognized.

Faculty Notes

Faculty members of this department include these chairholders: Samuel Miller Allen, POSCO professor of physical metallurgy; Angela Belcher, John Chipman career development associate professor of biomedical engineering; Yet-Ming Chiang, Kyocera professor of ceramics; Michael John Cima, Sumitomo Electric Industries professor of engineering; Thomas W. Eagar, Thomas Lord professor of materials engineering and materials systems; Yoel Fink, Thomas B. King assistant professor of materials science; Eugene A. Fitzgerald, Thomas Lord professor of materials science and engineering; Merton Corson Flemings, Toyota professor emeritus of materials processing; Lorna J Gibson, Matoula S. Salapatas professor of materials science and engineering; Darrell J. Irvine, Karl Van Tassel assistant professor of biomedical engineering and materials science and engineering; Klavs Flemming Jensen, Lammot du Pont professor of chemical engineering and professor of materials science and engineering; Lionel C. Kimerling, Thomas Lord professor of materials science and engineering; Claude H. P. Lupis, Danae and Vasilis Salapatas professorship in chemical metallurgy; Nicola Marzari, Amax career development assistant professor of computational materials science; Christine Ortiz, John Chipman assistant professor of materials science and engineering; Adam C. Powell, IV, Thomas B. King assistant professor of materials engineering; Caroline A. Ross, Lord Foundation associate professor of materials science and engineering; Michael Francis Rubner, TDK professor of materials science and engineering; Donald Robert Sadoway, John F. Elliott professor of materials chemistry; Subra Suresh, Richard P. Simmons professor of metallurgy and materials science and engineering; Edwin Lorimer Thomas, Morris Cohen professor of materials science and engineering; Carl Vemette Thompson, II, Matoula Salapatas professor of materials science and engineering; and John Bruce Vander Sande, Cecil and Ida Green distinguished professor.

Student Awards

Undergraduate Awards

The department award for outstanding senior thesis was presented to Robin Ivester of Charleston, South Carolina, for her thesis entitled, "Fabrication and Magneto-Mechanical Characterization of Ni-Mn-Ga Ferromagnetic Shape Memory Composites for Energy Absorption and Damping." The best 3-B internship report award was presented to Steven Tobias of Plainview, New York, for his report on "Study of the Structure and Electrical Transport Properties of Near Stoichiometric Indium Monoselenide." The award for outstanding service to the DMSE community was presented to Lauren Frick of North Huntingdon, Pennsylvania, in recognition of her activities as an active and innovative president of SUMS. A certificate of honor for a perfect 5.0 cumulative grade point average was presented

to Trisha Montalbo of State College, Pennsylvania, who was also inducted into Phi Beta Kappa. Afua Banful of Kia Accra, Ghana, was named outstanding junior in the DMSE Class of 2002 and Trisha Montalbo was named outstanding student in the DMSE Class of 2002. Tiffany Santos of Valdosta, Georgia received honorable mention from the Association of MIT Alumnae's senior academic award and also received an Undergraduate Materials Research Initiative (UMRI) award from the Materials Research Society (MRS); these awards are designed to introduce undergraduates to the excitement of discovery through research in materials science and engineering by providing funds for research and subsequent awards.

Tau Beta Pi inductees this year were DMSE seniors Brad McCoy, Nina Pocek, and Steven Tobias; and juniors Afua Banful, Jessica Dai, Casey Dwyer, Jamie Mak, and Frances Wong.

Graduate Awards

Heidi Burch was named a Materials Day Poster Session winner for her presentation entitled "Toward Development of an Edible Photonic Crystal." Amy Grayson, a PPST/DMSE grad student advised by Professors Michael Cima and Robert Langer was co-winner of PPST's new Institute-wide OMNOVA Signature award for excellence in polymer research for her research on "A Resorbable Polymeric Microreservoir Device for Drug Delivery." Abel Hastings (MEng 2002) was awarded the FEF (Foundry Education Foundation) scholarship for an outstanding student with an interest in metals casting. Christopher P. Henry received honorable mention for his presentation at the International Society for Optical Engineering's (SPIE) annual conference in San Diego, California. Jinsang Kim, PhD in materials science and engineering in June 2001, received the International Union of Pure and Applied Chemistry (IUPAC) award for the best PhD thesis in chemical science. Hartmut Rudmann received an MRS graduate student award at the MRS meeting in Boston in December 2001. Augustine Urbas was also named a Materials Day Poster Session winner for his presentation on "Block copolymer photonic crystal active materials." Nicole Zacharia is the 2001 winner of the John Wulff award for excellence in teaching.

Future Plans

Vigorous effort to design and implement the new undergraduate curriculum will continue in the coming year. Faculty have committed to a "dry run" of the new curriculum in the spring semester 2003 and a roll-out to department sophomores in September 2003.

Several major renovation and construction projects have been initiated with work to continue over several years. Through an agreement with the Physics Department and the Institute, DMSE will be creating a number of new undergraduate teaching laboratories in Building 8 on the Infinite Corridor. Architects are working with the department to finalize designs for the new laboratories, as well as space for a new DMSE headquarters, a student services office, and faculty offices on the first floor of Building 6.

Subra Suresh
Department Head
Professor of Materials Science and Engineering

More information about the Department of Materials Science and Engineering can be found on the web at http://dmse.mit.edu/.

Department of Mechanical Engineering

This has been a good year for the Department of Mechanical Engineering. We were ranked once again as the number one department in the field by *U.S. News and World Report*. Our students and faculty have continued to be recognized for their originality and impact on research, education, and leadership in the field of mechanical engineering. The various honors bestowed include awards from national and international organizations such as the National Academy of Engineering, the Guggenheim Foundation, ASME, IEEE, the American Academy of Arts and Science, and the Institution of Design Engineers in the United Kingdom.

In the fall, we celebrated the opening of the BJ and JH Park Lecture Halls in Building 3, which replaced the traditional classrooms 3-270 and 3-370. One of the new rooms allows us to implement hands-on self-discovery modes of education where students carry out simple experiments during lecture. These rooms are also used for distance education and the Singapore-MIT Alliance financed state of the art equipment for this purpose. Construction of these classrooms was made possible by a generous gift from Dr. and Mrs. BJ Park.

In the spring, we dedicated the Hatsopoulos Laboratory for Microfluid Dynamics. This laboratory was created by a generous gift from Dr. George and Daphne Hatsopoulos. Microfluid dynamics concerns the understanding and engineering application of fluid behavior at microscopic—but not atomic—scales. Today, the laboratory houses the research of eight faculty, 40 students, and 10 post-doctoral fellows, working on developing microscale mechanical and electrical instrumentation, processing and nano-manufacturing, and related biological, medical, biomedical, and optical applications.

This year the department undertook a vigorous search and recruiting program for new faculty. In addition to ad hoc search committees, a centralized faculty hiring committee was formed to help coordinate activities between committees and to develop a database. We had searches in many of the core areas of mechanical engineering—controls, design, dynamics, energy, fluids, manufacturing—while looking for faculty members who brought new insights or worked on completely new areas within these fields. The faculty members we have hired include persons working on new energy technologies, microfluidics, biophysics, MEMS design and nano-manufacturing. They include four women faculty members.

In order to keep up with the changing nature of the field, we have revised our doctoral qualifying examination. Students are now able to take examinations in the core areas of mechanical engineering as well as in their area of specialization. It is anticipated that new examinations will be offered in areas such as optics, biophysics, micro and nano-scale engineering.

This year, we were visited by an ABET accreditation team, who reviewed our programs, including our 2A program. The 2A program has existed for many years, offering significant flexibility to undergraduates interested in following a less conventional program. The resulting degree has not, up to this point however, been accredited. Based upon this year's ABET review, it appears that this program will now be accredited as a non-traditional engineering program; the final decision from ABET will not be known until August. We see this as a significant new development that will expand and enrich our undergraduate programs.

The second textbook in the MIT-Pappalardo Series in Mechanical Engineering was published by Oxford University Press. *Energy and the Environment*, by James A. Fay and Dan Golomb, draws on dynamics, fluid mechanics, thermodynamics, heat transfer, and the related sciences, and exposes student to a societal problem of great current concern—the use of energy and the local, regional and global environmental effects that its use engenders.

Jane and Neil Pappalardo have pledged another gift to the department. This one will create a new laboratory for nano-technology. This facility is expected to include a nano-fabrication facility and a suite of mechanical engineering laboratories with emphases on bio-chemical, thermo-fluid and opto-mechanical phenomena. This is the fourth major gift to the department from the Pappalardos.

Undergraduate Program

Undergraduate Enrollment

	AY97	AY98	AY99	AY00	AY01	AY02
Sophomores	126	116	121	106	83	77
Juniors	128	125	117	116	91	92
Seniors	125	121	132	108	110	115
Total	379	362	370	330	284	284

The following honors and prizes were awarded to our undergraduate students. Daniel Sandoval was awarded the Student Leadership Award from the Hispanic Engineer National Achievement Awards Conference. Stephanie Praster was given the Department Service Award. Sebastian Heersink received the Padmaker P. Lele Student Award for outstanding thesis. The Padmaker P. Lele Student Award for outstanding UROP project was given to Stephen Samouhos. The Padmakar P. Lele Student Award for UA's was awarded to Mark Jeunnette, Carla Pienknagura, and Stephanie Praster. William Fienup, Grant Kristofek, Nicholas Powley, and Daniel Benhammou received the Luis De Florez Award for ingenuity and creativity. Peter Griffith Prize for outstanding experimental projects was given to Jennifer Fiumara and Sofy Taru. AMP Inc. Award for outstanding performance in 2.008 was given to Nur

Aida Abdul Rahim (at MIT from Cambridge University on the CMI program) and Malima Wolf. Whitelaw Prize for originality in design was awarded to Nur Aida Abdul Rahim (at MIT from Cambridge University on the CMI program) and Erin Hul. International Design Competition team included Angela Chen, Margaret Cho, Emily Cofer, Eric Dominguez, Henry Hilton, Martin Jonikas, Aaron Parness, Nicholas Powley, Justin Ruflin, and Eric Tung. The Wunsch Foundation Silent Hoist and Crane Award for outstanding undergraduate project or thesis related to materials handling went to Andrew Wallace, Jennifer Cooper, Veronica Garcia, Federico Gutierrez, Basilia Huang, Michael Roberts, Abraham Schneider, and Mary Kathryn Thompson.

The mechanical engineering honor society, Pi Tau Sigma, and our ASME student chapter have both been active this past year and contributed significantly. Pi Tau Sigma was led by Mary Kathryn Thompson, president; Carla Pienknagura, vice-president; Veronica Garcia, secretary; Federico Gutierrez, treasurer; and Maria-Louisa Izamis, tutoring program coordinator. The ASME student chapter was led by Collins Ward, president; Mary Kathryn Thompson, vice-president; Alex Johnson, secretary; Jen Blundo, treasurer; and Marius Hauser, new member recruitment.

Graduate Program

Our graduate program continues to be strong with a total of 359 students. Of the 176 students in the master's program, 31 percent were foreign, 25 percent were women and 10 percent were minorities. Of the 183 students in the doctoral program 59 percent were foreign, 11 percent were women and three percent were minorities. Our students were supported by 241 research assistantships, 25 teaching assistantships, 18 NSF fellowships, four DOD fellowships and 69 other fellowships.

Graduate Enrollment

	AY97	AY98	AY99	AY00	AY01	AY02
Master's	228	212	220	225	197	176
Doctoral	176	169	172	159	181	183
Total	404	381	392	384	378	359

This past year 641 students applied for admission to our graduate program; 28 percent of them were offered admission and 57 percent of whom matriculated.

The following honors and prizes were awarded to our graduate students. The Departmental Service Award was given to Katie Lilienkamp. Aimee Angel and Ephrat Most received the Meredith Kamm Memorial Award for outstanding performance. Carl G. Sontheimer Prize for innovation and creativity was awarded to Jason Melvin.

The student organization of ME graduate women, MEGAWomen, has been very active this year, having organized numerous social events for female and male students, as well as qualifying examination preparation sessions. The officers of MEGAWomen were Aimee Angel and Ephrat Most, co-presidents.

Faculty Notes

Tenure was granted to Professor David Wallace. Professor Seth Lloyd was promoted from associate to full professor. Dr. Hermano Igo Krebs was promoted from research scientist to principal research scientist. Dr. Mandayam Srinivasan was promoted from principal research scientist to senior research scientist.

Gang Chen joined the department as an associate professor of mechanical engineering. He received his BE and ME from Huazhong University of Science and Technology in 1984 and 1987, respectively. He received his PhD from the University of California at Berkeley in 1993. He was an assistant professor at Duke University and an associate professor at UCLA before coming to MIT. His principal fields of interest are heat transfer, thermoelectrics, and micro-electro-mechanical systems.

George Haller joined the department as an associate professor of mechanical engineering. He received his master's from the Technical University of Budapest in 1989 and his PhD from the California Institute of Technology in 1993. Before joining MIT, he was an associate professor at Brown University. His principal fields of interest are nonlinear dynamical systems, chaos, nonlinear oscillations, transport and mixing, and turbulence.

Simona Socrate joined the department as an assistant professor of mechanical engineering. She received her laurea in nuclear engineering and doctorate in energetics from the University of Rome, Italy, in 1984 and 1991, respectively. She also received a master's and PhD in mechanical engineering from MIT in 1990 and 1995, respectively. Her principal fields of interest are the mechanical behaviors of materials—the development and numerical implementation of constitutive models, biomaterials and heterogeneous material systems.

Professors David Cochran and Sunny Siu resigned from the department.

Professor James Keck was elected a fellow of the National Academy of Engineering. Professor Gang Chen has been awarded a Guggenheim Fellowship. Professor Elias Gyftopoulos was awarded ASME's Edward F. Obert Award for an outstanding paper on thermodynamics. Professor David Gordon Wilson and his high-tech start-up Wilson TurboPower Inc. won the grand prize in the National Social Venture competition. Professor Steve Dubowsky was awarded ASME's Machine Design Award and elected an

IEEE fellow. Professor Nam P. Suh was elected a life fellow of ASME. Professor Harry Asada was elected a fellow of ASME. Dr. Anuradha Annaswamy was elected a fellow of IEEE. Professors John Brisson and Ernest Cravalho received the Baker Foundation Award for undergraduate education. Professor Sanjay Sarma received the Keenan Award for innovation in undergraduate education. Professor David Trumper received the Ruth and Joel Spira Award for teaching. Professor Derek Rowell received the SoderbergAaward for service. Dr. Rajesh Jugulum, a postdoctoral associate, received the Armand V. Feigenbaum Medal from the American Society for Quality.

The following members of staff were also recognized: the Caloggero Award for service went to Maureen Lynch; and three of the School of Engineering's Infinite Mile Awards went to Debra Blanchard, Dick Fenner, and Peggy Garlick.

Rohan Abeyaratne
Department Head
Berg Professor of Mechanical Engineering

More information about the Department of Mechanical Engineering can be found on the web at http://me.mit.edu/.

Department of Nuclear Engineering

U.S. News and World Report again rated MIT's Department of Nuclear Engineering number one in its field. The consistency of this ranking over many years reflects the quality of scholarship by students and faculty alike in this department.

This past year has been a highly productive one in both education and research. On the education front, there were a relatively large number of applicants for our graduate program, with a great majority of the admitted students agreeing to join the program. The department, under the leadership of Professor Andrew C. Kadak, initiated a major effort to increase undergraduate enrollment. This included a complete revamping of our undergraduate curriculum and an intensive recruiting program. As a result, we saw a large increase in the number of freshman who selected nuclear engineering as their major (15), which is actually a record for the department.

On the research front, there was strong and increased interest as well as funding in all the major areas of the department: fission and energy systems, fusion, and radiation science and technology. A description of some of these very interesting projects is provided below. Of particular interest is the MIT nuclear reactor. For many years the nation's university research reactors have been underfunded by the US Department of Energy (DOE), making it difficult for them to compete with national laboratory reactors. This past year the DOE recognized the problem and initiated a new peer-reviewed competitive program aimed at ameliorating the situation. The MIT proposal, prepared by Dr. John Bernard, director of the Nuclear Reactor Laboratory (NRL), in collaboration with Nuclear Engineering faculty members, ranked number one in the final review. As a result, the NRL will receive over $1 million per year over the next five years, enabling it to strengthen its program instrumentation, scientific support, and user friendliness.

Undergraduate Program

Eighteen students were enrolled in the undergraduate program during the past year. This included two sophomores, six juniors, and 10 seniors. Five students completed requirements for the bachelor's degree in nuclear engineering.

Undergraduate curriculum development focuses on strong fundamentals with hands-on experiences in all aspects of nuclear science and engineering applications from energy, accelerators, medicine, research, and policy.

In the spring semester Professor Sidney Yip led a team of nine other faculty colleagues from several departments and HST in developing a new undergraduate subject, Introduction to Modeling and Simulation, for students Institute-wide. This subject will be offered formally next spring as 22.00 with joint listing in six other departments in the Schools of Engineering and Science.

Graduate Program

The graduate program totaled 111 students during the fall term. Of this number, 21 were enrolled for their first term. Thirty-nine percent are specializing in radiation science and technology; 41 percent are working in fission and energy studies, and 20 percent in fusion. The department awarded 14 master's degrees, two nuclear engineer's degrees and 11 doctoral degrees during the academic year.

In Professor Kenneth R. Czerwinski's class, 22.76 Nuclear Chemical Engineering, students performed plutonium-uranium separations with reactor irradiated materials. This is the only university class in the US to provide students the opportunity to work with actinides.

Professors Jacquelyn C. Yanch and Yip offered a new subject, Neutron Interactions and Applications, primarily for the students in the radiation science and technology program, but the intention is also to make the contents have wider appeal. A particular emphasis of the subject is the application of Monte Carlo sampling methods to radiation transport.

Faculty Honors, Awards, and Activities

Professor Jeffrey P. Freidberg received the Fusion Power Associates Board of Directors Leadership Award for 2002. The award is presented annually to those individuals who have shown outstanding leadership qualities in accelerating the development of fusion. He continues to serve as a member of the DOE Fusion Energy Sciences Advisory Committee (FESAC) and served as chairman of the FESAC Burning Plasma Panel.

Professor Neil E. Todreas continues his service to the DOE as a member of the Nuclear Energy Research Advisory Committee and as co-chairman of its subcommittee for the Technology Roadmap for Advanced Generation IV Nuclear Energy Systems. He gave invited presentations on the progress of this roadmapping activity at the 10th International Conference on Nuclear Engineering meeting held in Arlington, Virginia, in April and at the President's Session at the ANS Annual Summer Meeting in Hollywood, Florida, in June. His service continues on the National Nuclear Accrediting Board for operating nuclear reactor training programs.

Professor David G. Cory, Dr. Timothy Havel and their colleagues continue to make advances in the theory, practice and implementation of quantum information processing. In particular they have implemented a solid-state version of an NMR quantum information processor that promises to provide more precise control over larger Hilbert spaces than is available in the liquid state.

Professor Cory (editor in chief) and Dr. Havel (managing editor) have formed a new journal, *Quantum Information Processing*, published by Kluwer Academic. QIP is an international forum for the publication of peer-reviewed papers on all aspects, theory and experimental, of quantum information processing.

Professor Cory received the Ruth and Joel SpiraAward for Distinguished Teaching. This award acknowledges the tradition of high-quality engineering education at MIT.

Professor Kent F. Hansen received the Graduate School Council Teaching Award.

Also, the PAI Outstanding Teaching Award (awarded by the student chapter of the American Nuclear Society) was presented to Professor Hansen.

Professor Sow-Hsin Chen received the first Career Achievement Award in nuclear engineering in May 2002.

Professor Czerwinski continued his interactions with Conservatoire National des Arts et Métiers, where he was an invited professor for four weeks. This involved research on actinide-lanthanide separations and teaching at Ecole Nationale Superieur de Chimie de Paris. Professor Czerwinski also made a presentation at CEA Marcoule on the specation of actinide in waste forms. The Marcoule group investigating waste forms is developing a joint research program with Professor Czerwinski.

Professor Czerwinski was a visiting instructor on actinide chemistry for the Department of Energy Radiochemistry summer school at Brookhaven National Laboratory.

Professor Czerwinski was an invited speaker at ACTINIDES 01. His presentation described the use of actinide speciation in environmental remediation. The method is now being used on remediation efforts in Massachusetts and California.

Professor Czerwinski was elected president of the Radiochemistry Research and Education Consortium.

Professor Kazimi gave ten invited lectures during the past year, five of them at international settings. In September he spoke at GLOBAL2001 in Paris on "Back End of the Fuel Cycle, From Research to Solutions." In January 2002 he gave two lectures on emerging directions of nuclear technology at Tsinghua University in Beijing and one lecture at the MIT Annual Japan Industry Forum in Tokyo. In March he spoke on nuclear energy for developing countries at the second meeting of the Arab Science and Technology Foundation (ASTF) held at Sharjah University, United Arab Emirates. He was a member of the steering committee for the International Congress on Advanced Nuclear Power Plants (ICAPP) held in Hollywood Florida in June 2002 at which he also gave an invited lecture on Optimization of the Fuel Cycle. He served as a member of the review committee of the Nuclear and Energy Systems Division of INEEL. At MIT, he served as director of the Center for Advanced Nuclear Energy Systems (CANES), chairman of the MIT Research Reactor Safeguards committee and on the MIT Sea Grant Program advisory board.

Professor Emeritus Elias P. Gyftopoulos was honored by the American Society of Mechanical Engineers for his papers, "Entropy—Part I: Statistics and Its Misleading Disorder" and "Entropy—Part II: Thermodynamics and Perfect Order." He received the society's Edward F. Obert Award.

Professor George E. Apostolakis was re-elected chairman of the statutory advisory committee on reactor safeguards of the US Nuclear Regulatory Commission effective January 1, 2002. He continues to serve on the International Nuclear Technology Committee that advises the governments of three German states (Baden-Württemburg, Bavaria, and Hesse) on nuclear technology matters. He was re-elected secretary of the International Association for Probabilistic Safety Assessment and Management. He continues to serve as the editor-in-chief of the international journal *Reliability Engineering and System Safety*. He chaired the Independent Peer Review Panel that reported to senior NASA management on the Probabilistic Risk Assessment of the International Space Station. He was an invited speaker at the fourth National Symposium on Space System Risk Management sponsored by the Aerospace Corporation and the Air Force Space and Missile Systems Center. He was an invited panelist at the workshop on "Performance-Based Regulation: Prospects and Limitations in Health, Safety, and Environmental Protection" sponsored by the John F. Kennedy School of Government of Harvard University.

Professor Ronald M. Latanision was a visiting professor at the University of Naples, Italy. He was appointed a Sauveur Lecturer by the Boston Chapter of TMS International.

Professor Ian H. Hutchinson continues as honorary editor of the journal *Plasma Physics and Controlled Fusion*. He presented an invited lecture entitled "Plasma Fusion Research and the Technical and Spiritual Challenges of Sustainable Energy" at the triennial meeting of the International Union for Vacuum Science, Technique, and Applications (IUVSTA) hosted by the American Vacuum Society in November 2002.

Professor Jeffrey A. Coderre was awarded the Norman C. Rasmussen Career Development Chair by the Department of Nuclear Engineering.

Professor Linn W. Hobbs, who was given a joint appointment in the Department of Nuclear Engineering this year, was made an officer of the Order of the British Empire by Queen Elizabeth for his contribution to British-American educational programs through his long service with the Marshall Scholarship program. Professor Hobbs was appointed a member of the National Research Council

(National Academy of Sciences) committee on improving the scientific basis for managing nuclear materials and spent nuclear fuel. An earlier NAS/NRC committee, on which he served, the committee on long-term research needs for radioactive high-level wastes at DOE sites, published its findings in July 2001. Professor Hobbs was also appointed to an ongoing DOE independent review panel to evaluate the Radioactive Isolation Consortium, LLC, advanced vitrification system.

At MIT, Professor Hobbs won the Institute's 2002 Arthur C. Smith Award for his sustained contributions to undergraduate education and student life.

Research

Fission

The Center for Advanced Nuclear Energy Systems has expanded its research programs with the awarding of several projects to the center faculty. Two new DOE grants from the Nuclear Energy Research Innovation (NERI) program were initiated this year. This brings the total number of NERI projects involving MIT to 14 out of 69 winning projects (more than 600 applications were submitted to the NERI program) over the three cycles to date.

Professor Kazimi and Dr. Pavel Hejzlar received with industrial partners a three-year, $2.4 million NERI grant for the development of internally cooled annular fuel for pressurized water reactors (PWR). The project involves design and manufacturing optimization of such fuel, as well as testing some of the design characteristics in the MIT reactor. If successful, such fuel will allow significantly higher power densities in the PWR core (up to 50 percent) with safety margins that are equivalent or enhanced relative to today's reactors.

The other NERI project involved Professor Latanision who is working with INEEL to study the corrosion of structures in water at temperatures about 550 C and pressures of 35 MPa, representative of those in a thermodynamically supercritical water reactor.

Two projects on the design of gas-cooled fast reactors were initiated under professor emeritus Michael Driscoll. One involving the optimization of the plant design to provide wide safety margins making use of added thermal capacity in the core through an appropriate core matrix. The other involving the design of a direct cycle thermal conversion system using supercritical CO_c as the working coolant. This brings the number of reactor system concepts being investigated at CANES to four—the integral system LWR with long fuel cycle core, the modular, helium cooled pebble bed reactor, the lead-bismuth cooled fast reactor and the supercritical CO_2 gas turbine reactor. The four concepts are supported by INEEL through a cooperative agreement using laboratory directed funds, and through a number of NERI projects.

Several other programs involving advanced fuels and fuel cycles were initiated. Professor Ronald G. Ballinger initiated a project supported by the Electric Power Research Institute to investigate the effects of noble metals on corrosion of the cladding in boiling water reactors. He was also the recipient of an International NERI award to investigate the migration of fission products in particle fuel coatings. Professor Kazimi and Dr. Hejzlar started a project for investigating the feasibility of transmutation of plutonium and minor actinides in light water reactors using neutronically inert materials to host the actinide fuel. Application of lead-cooled reactors for transmutation of actinides in inert fuel hosts were the subject of a new project by Professor Todreas and Dr. Hejzlar. Professors Kazimi and Czerwinski initiated a DOE Cooperative Research and Development Agreement (CRADA) for cleanup of uranium metal scraps. That CRADA involves Global Nuclear Fuel, Brookhaven National Laboratory and the Uzbekestan Center for Nuclear Fuels at Ulba. Professors Kazimi and Driscoll continue to investigate the feasibility and economics of very high burnup uranium and thorium fuel cycles in PWRs.

Professor Todreas continues as principal investigator for the following two advanced nuclear reactor conceptual design projects. The first is a low-power-rating modular light water reactor being developed by an international consortium of industry, laboratory, utility, and universities led by Westinghouse and sponsored by the DOE's Nuclear Energy Research Initiative program. The second is a large-power-rating lead-bismuth eutectic-cooled fast spectrum reactor aimed at both low electricity production cost and actinide destruction being designed in collaboration and with the sponsorship of the Idaho National Engineering and Environmental Laboratory.

Professor Latanision's collaborative research with faculty at the Pennsylvania State University has reached the point of producing reference and pH electrodes that function in high temperature–high pressure water. These electrodes will allow us to examine our prediction that control of dealloying and stress corrosion cracking of the Hastelloy C-276 materials of construction of supercritical waters oxidation systems can be achieved with appropriate thermodynamic control of the operating protocol. Tests are underway.

Advanced Reactor Research: Modular Pebble Bed Reactor

What started as an IAP project in 1998 has been transformed into a major design project to develop an advanced reactor that can meet the public's expectations for safety and the industry's expectations for competitiveness. As evidence of global climate change mounts, the importance of nuclear energy as an element in the world's energy mix is becoming apparent. The Department of

Nuclear Engineering is in the forefront of advanced reactor development with the modular pebble bed reactor (MPBR) as one of the earliest technologies that could be deployed.

With support from the INEEL and competitively awarded DOE's Nuclear Energy Research Initiative (NERI) grants, the pebble bed project team has focused on the conceptual design of the complete power plant. The major effort is aimed at identifying the significant technical issues that need to be addressed to bring this technology forward. The current research and development initiatives include developing a new state-of-the-art fuel performance model with irradiation testing of new fuels; safety analysis including air ingress which includes a collaboration with the Jülich Research Center in Germany in their upcoming experiments at the NACOK facility; development of a balance-of-plant design that uses a dramatically different approach to the power conversion unit by employing an indirect cycle with an intermediate helium-to-helium heat exchanger; core physics analysis using advanced Monte Carlo techniques. This capability is presently being expanded by the installation of a Beowulf cluster of 30 PCs that will permit performing Monte Carlo core physics calculations including depletion and incorporating online refueling capabilities.

One of the major new innovations being developed is to radically change how nuclear power plants are built. Instead of building larger and larger plants, the modular pebble bed reactor is small, only 120 megawatts electric (about one-tenth the size of current generation plants). This size allows for quicker construction and easier financing. The design is aimed at high modularity allowing for factory fabrication and site assembly using a "lego" type approach. Shown here is an example of the modular design in which the entire balance of plant can be shipped to the site in 21 trucks carrying space frame components that are simply bolted in place. The target is to build the plant in about two years that could make the plant competitive with natural gas power plants.

Any new nuclear plants will require a design that does not increase proliferation risks. The project team has also performed scoping work on non-proliferation and safeguards. Preliminary studies have also been completed on nuclear waste disposal. The senior design class has also developed a conceptual design of a power distribution monitoring system for the pebble bed reactor using tomographic imaging techniques. Recently completed was a class-designed experiment on pebble flow and mixing in the reactor core. This figure shows some members of the class in the laboratory with their experimental assembly that they used to confirm the laminar pebble bed flow in conjunction with the Department of Mathematics.

In the future, proposals have been submitted which include collaborations with several industrial firms to design and develop an advanced instrumentation and control system that could have generic applications that would allow for "hands-free" start-up of the reactor in a modern control room environment. A proposal has also been submitted on a computational fluid dynamics analysis of helium flow in a pebble bed reactor under normal and accident conditions that will be experimentally benchmarked. This flow methodology will be used to better understand temperatures in pebble bed reactors. As part of the safety research, a proposal has also been submitted to test the oxidation rate of graphite used in fuel and reflectors for high temperature gas reactors and to develop advanced coatings to eliminate or reduce the consequences of air ingress. This work has been proposed in collaboration with MIT's Plasma Science and Fusion Center, Battelle Pacific Northwest Laboratories and Jülich Research Center. The MIT Research Reactor will also be used to perform a series of graphite irradiation tests that are important in the safety and economics of high temperature gas reactors.

One of the unique applications of high temperature gas reactors is in the production of hydrogen and other process heat applications. This new area of development will attempt to link the nuclear plant to a hydrogen production facility in a safe manner. The interesting aspect is to identify what design features would be necessary from the standpoint of the safety implications of such collocation and whether such a combination is practical from the regulatory standpoint. For more information please contact Professors Kadak or Ronald G. Ballinger.

Professor Czerwinski continued investigating the speciation of neptunium in spent nuclear fuel with Argonne National laboratory on a DOE-NERI supported project. The project is yielding results on the expected repository behavior of neptunium.

Speciation of actinide containing waste forms have been performed for the United States Air Force. The results were used in remediation of contaminated sites and have lead to the development of a method for incorporating actinide speciation into environmental remediation.

A joint project with Ecole Nationale Superieur de Chimie de Paris (ENSCP), Conservatoire National des Arts et Métiers, Paris, and Los Alamos National Laboratory investigates lanthanide and actinide separations. Templated ion specific resins for uranium, thorium, neptunium, and americium have been synthesized. The project is supported by the Presidential Early Career Awards for Scientists and Engineers (PECASE) award.

Through a University Research Collaboration (URC) project on Th fuel headed by Professor Kazimi, investigations on the behavior of Th fuel in a repository are continuing. Recent efforts for the first time examined the effect of gamma radiation on spent fuel speciation.

Radiation Science and Technology

Neutron capture therapy for cancer research, directed by Professor Otto K. Harling, continued for the 15th year with strong support from federal agencies. In the last year, significant progress was made in the development of this cellular tumor targeting therapy. The new fission converter based epithermal neutron irradiation facility (FCB) at the MIT research reactor was fully characterized and otherwise readied for clinical studies. The dosimetric characterizations verified that the beam from this facility combines the highest intensity of any such facility in the world with near optimum beam purity. During the year all necessary approvals were finalized for the initiation of clinical trials. These trials will be carried out under the medical direction of Dr. Paul M. Busse from the Harvard Medical School–affiliated Beth Israel Deaconess Medical Center. Two separate clinical trials are now open for subject accrual. One trial is for intracranial gliobastoma multiforme and metastatic melanoma, and the second trial is for metastatic melanoma on the peripheries. Both trials are funded and approved by the National Cancer Institute. The US Department of Energy provides funding for the staff and infrastructure needed to support these clinical trials and other neutron capture therapy research centered at the MIT reactor.

The US Department of Energy is also supporting Professor Harling's group in the upgrading of a second neutron beam at the MIT reactor. This beam is a high intensity thermal neutron beam to be used for small animal irradiations and clinical studies of skin cancer therapy.

The MIT/Harvard program in neutron capture therapy is the leading research program in this field in the US and is acknowledged as one of the leading programs in the world.

Research in Professor Coderre's laboratory continues in two main areas: boron neutron capture therapy (BNCT) and the basic radiation biology of alpha particles. The BNCT project focuses on measuring the sensitivity of the normal lung to the high linear energy transfer radiations produced during BNCT. This project will also investigate the mechanisms by which radiation causes damage in the lung and will explore possible biochemical approaches to reduce these side effects. The methodology has been established to measure breathing rates in rats following whole lung irradiation. A Phillips RT 250 Orthovoltage x-ray machine, donated to the Department of Nuclear Engineering, has been installed and calibrated and will be used as the control radiation for all radiobiology experiments.

Americium-241 foils have been purchased and fabricated into alpha particle irradiation sources for cell culture experiments. These sources span five orders of magnitude in intensity and will provide a resource for development of a tumor micrometastasis model that allows the quantitative analysis of the effects of localized deposition of alpha particle radiation. This system will model radioimmunotherapy, where alpha-emitting nuclides attached to monoclonal antibodies are delivered non-uniformly to the surface of a tumor metastatic site, and will allow systematic studies on ways to improve prostate tumor therapy.

Professor Coderre has established a research collaboration with Professor Peter Dedon, of the Biological Engineering Division, to look at the effects of alpha particle radiation on DNA in solution. Professor Coderre was awarded a pilot study grant by the Center for Environmental Health Studies in the Biological Engineering Division to study a phenomenon known as the "bystander effect" where cells not directly hit by radiation, nevertheless, show damage. This effect has implications for assessment of the risk associated with exposure of the lung to radon alpha particles.

Quantum Information Processing

Professor Cory and his students continue to explore NMR approaches to quantum information processing through a set of collaborations with Dr. Havel (NED), Professor Seth Lloyd (ME), Professor Eddie Farhi (Physics), Dr. Raymond Laflamme (University of Waterloo), Dr. E. Knill (LANL), and Dr. J. Yepez (AFRL). We have developed new means of coherent control (in the presence of decoherence and incoherent interactions) that achieve experimental fidelities of 0.99.

We have constructed a new scheme for extending the success of NMR approaches to QIP to larger systems via a solid-state device capable of coherently controlling 10–30 qubits. We are using this scheme to explore quantum complexity and the transition from quantum to classical dynamics.

We have investigated quantum chaos with the aims to develop experimental signatures which differentiate regular from chaotic dynamics, and to show the connection of chaotic couplings to an environment with decoherence.

We have defined and experimentally implemented a new model of quantum decoherence that requires a minimum number of quantum resources. This system is coupled to a simulated quantum environment that is periodically and randomly re-dressed to introduce user defined decoherence.

NMR of Heterogeneous Semi-Solids

In collaboration with Dr. S. Singer, and Dr. Pabitra Sen of Schlumberger Doll Research Laboratory, we have continued to explore the structure and fluid dynamics of complex media. The heterogeneity of the sample itself sets up a signature of the local geometry that provides a simple and direct means of characterizing micron scale structures. Knowledge of this provides insight into cellular differentiation and fluid transport through complex structures.

NMR Imaging of Neuron Structure and Function

Dr. Alan Jasanoff (a Whitehead fellow at MIT) has developed the tools to enable the neuron structure and response of blowflies to be explored at high resolution via NMR microscopy. The use of blowflies provides a stable and well-characterized test bed, while simultaneously permitting near cellular resolution in the NMR. This in turn enables the observation of neuron activity in living/functioning tissue with the markers being directly traceable to neuron biochemistry. Dr. Jasanoff is developing a series of exodenous markers of biochemical response for neuroscience.

Professor Yip is actively continuing his research in the area of materials modeling, and lecturing during the past year at international meetings in Italy, France, and the UK. He is serving as a core editor on an encyclopedia project on materials modeling, the long-term objective being to establish computational materials as a field analogous to computational physics and computational chemistry.

Professor Chen and his graduate student Wei-Ren Chen have discovered a new phenomenon—a glass-to-glass transition in a colloidal system with very short-range attractive interaction—using neutron scattering technique. This type of inter-particle interaction is unique to colloidal systems due to their large dimensions (~ 100 Å) and cannot be realized in atomic or molecular systems. Collorary to this phenomenon is the existence of the end point of this transition line, called A3 singularity point, where the two types of glass states become identical. Their neutron scattering experiment also verifies the existence of this end point. Their finding will appear in a paper in the August 1 issue of the *Physical Review E*. Because of this discovery, Professor Chen was invited to give a lecture in a summer school on spectroscopic investigation of collective excitations in condensed matter, which took place in the International Center for Theoretical Physics, Trieste, Italy, in June 2002.

The events of September 11 have led to an increased interest in Dr. Richard C. Lanza's work on explosive and contraband detection. This resulted in a significant amount of publicity on this work including newspaper and TV interviews, both locally (WGBH) and nationally (the *Today Show*). Currently, there is a major effort to expand this technology into other areas of concern.

Medical Imaging

The work on coded aperture imaging for simultaneous high sensitivity and high resolution of radioisotopes has been expanded to concentrate on small animal imaging (with Ralph Weissleder, Center for Molecular Imaging Research at MGH), for cancer (John Frangioni, Beth Israel) and brain studies (CMIR), as well as application to pediatric imaging (Roberto Accorsi, Children's Hospital of Philadelphia). New mask fabrication techniques have reduced the cost and improved the performance; current limits appear to be around 700mm. The range of energies accessible has increased to 511 keV; which includes the use of PET isotopes such as ^{18}F. Extension of the technique to full three-dimensional imaging ("SPECT") appears possible based on work with collaborators (John Idoine, Kenyon College and University of Aberdeen).

An example of high-resolution imaging not possible without this technique is the in vivo imaging of a juvenile rat whose skeleton has absorbed a bone-seeking radiopharmaceutical. As part of an effort to understand the nature of addiction in small animal models, the Office of National Drug Control Policy has funded a three-year extension of coded aperture imaging specifically aimed at improving brain SPECT imaging. As part of this, two complete SPECT imaging cameras have been installed for use with the coded aperture system.

Contraband Detection

This work is continuing, including both neutron resonance radiography and prompt neutron activation methods. A passive imaging system is under design for use in the detection of illicitly transported fissile materials and nuclear devices.

Intense Neutron Sources

This program is a collaboration of work between MIT and the Lawrence Livermore National Laboratory for the development of intense, bright neutron sources, primarily for use in high-resolution fast neutron radiography. We have made progress in the development of windowless targets for this application. Fast neutron radiography is a potential method for non-destructive examination of large dense structures; which are not accessible to other techniques.

Neutron Phase Contrast Imaging

In collaboration with researchers at NIST we are designing and constructing an imaging system, which uses the wave properties of thermal neutrons to produce phase shift contrast images. This approach greatly enhances the contrast of small defects and features; initial estimates are that this technique may be as much as a factor of 1,000 times more sensitive than conventional radiography. A small test facility is being installed in a test beam at the MIT reactor.

Radiation Damage and Nuclear Waste

Professor Hobbs shifted his effort studying radiation-induced amorphization in silica and silicate solids to amorphization of silicon carbide, a compound likely to appear in near-first wall structural applications in fusion reactors. He and Dr. Xianglong Yuan (post-doctoral assistant) have shown using molecular dynamic topological

modeling that the surprisingly facile amorphization of SiC is driven by chemical disorder, which they show induces an actual reversible glass transition above a chemical disorder threshold. The finding has implications for predicting swelling of irradiated SiC, which derives largely from induced chemical disorder before the amorphization threshold is reached. Professor Hobbs and Dr. Yuan have also applied their topological methods, collaboratively with researchers at Pacific Northwest National Laboratory, to the definitive identification of point defect configurations in rapidly amorphizing SiC, in which a crystalline reference lattice has been effectively lost.

Professors Hobbs and Yip are participating, together with counterparts from the University of Cambridge, in a new Cambridge-MIT Institute (CMI) program on nuclear waste encapsulation in ceramic media. The aim of the three-year program, which also involves substantial support from British Nuclear Fuels Ltd., is to significantly improve design and radiation resistance of crystalline ceramic nuclear waste media for high-level nuclear waste and actinide storage through studies using modeling and experiment.

Fusion

High power plasma propulsion and high energy density laser-matter interaction

Professor Kim Molvig and Dr. Oleg Batishchev continued study of Variable Specific Impulse Magnetoplasma Rocket (VASIMR) experiment, which is being developed at the Advanced Space Propulsion Laboratory at NASA Johnson Space Center. The results for the optimized helicon plasma source operation were presented at several key meetings and incorporated into ongoing experiment. During his invited visit to the Universidad Nacional Autónoma de México (Mexico City, Mexico) in April 2002. Dr. Batishchev gave VASIMR project review lecture at the Instituto de Ciencias Nucleares.

Professor Molvig and Dr. Batishchev were invited to University of Michigan's Center for Ultrafast Optical Science in December 2001, where they presented a talk, "Advanced kinetic modeling of future CUOS/FOCUS experiments." A number of joint projects on high energy density laser-matter interactions have been initiated.

Dr. Batishchev was invited to visit the University of Alberta (Edmonton, Canada) in May 2002, where he presented a talk on kinetic simulation of non-local and thermal effects in laser heated plasma. He also gave an invited lecture at the mini-course on computational modeling of plasma (http://laser.phys.ualberta.ca/~rsydora/Icops-minicourse.html) entitled "Fokker-Planck and Vlasov-Particle-in-Cell Hybrid Methods" as a part of the ICOPS '02 meeting (Banff, Canada).

The Alcator C-Mod Experiment

The Alcator C-Mod tokamak is a major international fusion experimental facility, directed by Professor Hutchinson. Research continued in high-performance, compact magnetic plasma confinement. The upgrade to permit quasi-steady-state exploration of Advanced Tokamak operation with high fractions of self-generated current is nearing completion, under the leadership of Professor Ronald Parker. The 4.6GHz high-power RF sources are now installed and the wave launcher, being fabricated by collaborators, is due for installation in March 2003.

C-Mod is recognized as one of three major US national fusion facilities. The team includes approximately 16 MIT staff scientists, 18 MIT graduate students, 18 engineers, and 25 technicians. In addition, we have collaborators from around the world, bringing the total number of scientific users of the facility to about 120.

Facility operation this year has been limited, in part, by a scheduled deassembly for inspection of the magnet and upgrade of the divertor and other structures for higher current operation and improved diagnosis of the plasma. This engineering work was successfully completed. However, the more fundamental limitation to operation has been funding. Recognizing this problem, the Office of Fusion Energy Sciences of the US Department of Energy put forward a plan for substantial increases in funding for fiscal year 2003. The presidential budget proposed an increase of approximately $4 million for the facility, to enable a major increase in operations time, moving towards full utilization. Congress has not yet passed this proposal, but we are anticipating that it will be passed.

Highlights of recent research achievements include the following:

—We have show that the particle transport in the core of the plasma is reduced by putting the main source of heating about half-way out from the center of the plasma. In C-Mod this heating is the absorption of radio frequency waves through resonance with the cyclotron motion of the ions about the magnetic field. This process is naturally quite localized at a position where the frequency is equal to the ion cyclotron frequency. By changing the magnetic field, the resonance position can be moved. We find that with off-axis heating, the particle density peaks up slowly in the center of the plasma, consistent with a reduction of diffusivity, and the consequent effects of the known trapped particle pinch. More exciting still, we have shown that by applying heating at a second frequency, chosen to heat the plasma center, we can control the peaking of the density profile, and produce a stationary peaked profile. This result shows that the density profile can be actively controlled—a long-standing objective of transport research in tokamaks.

—A new turbulence imaging diagnostic has revealed new features of transport near the edge of the plasma. The

plasma is imaged using a fast camera with exposure times as short as a few microseconds. Short wavelength density perturbations are observed that show persistent blobs moving in time. This phenomenon, referred to generally as "intermittency," is characteristic of the edge turbulence, and provides important evidence for its underlying causes.

—In related research, the plasma turbulent transport outside the confined regions has been seen to be dominated by the intermittent transport phenomenon, and to be much more important than previously thought. Our experiments have shown that the blobs are capable of transporting much more plasma across to the solid surfaces of the main chamber than had been realized. This observation is important because it will affect the design of future experiments and their plasma-facing components.

—Short-wavelength waves have been directly observed arising from mode-conversion of the RF-heating power. Full-wave modeling, using state-of-the-art parallel computer programs, has shown that these wave phenomena are rather more complicated than had become widely thought, and include coupling to more than one type of electrostatic wave. The modeling is therefore correcting our understanding of the mode-conversion process, and the experiments are verifying the models.

A new neutral beam injector for diagnostics was installed. This beam was designed and fabricated by the Budker Institute in Siberia, and is part of a collaboration with the University of Padua.

The process leading to renewal of the Alcator research grant (due at the end of 2003) began with a US Tokamak workshop, held in May 2002, where the research plans were presented and discussed.

Graduate student Antonio Bruno, Professor Freidberg, and PSFC visiting scientist Dr. Jim Hastie completed the development of a new theory to predict the anomalous heat transport observed in ohmically heated reversed field pinches. The basic idea is to calculate the steady state temperature and magnetic field profiles assuming the plasma relaxes to a driven state of minimum energy that is marginally stable to all ideal and resistive MHD instabilities. The results agree remarkably well with existing experimental data and Antonio was selected to present an invited talk on this work at the annual Sherwood Fusion Theory Conference at the University of Rochester.

Student Awards and Activities

Extracurricular NED student functions centered on the MIT American Nuclear Society student branch. There were many social and athletic events during the year reflecting the interests of its members. The every other Monday afternoon seminar series, NED orientation for incoming students, the holiday party, and the international dinner are a few of the successful events from the past year.

Ian Parrish received the School of Engineering's Henry Ford II Award. The award is given to a senior engineering student who has maintained a cumulative average of 5.0 at the end of his/her seventh term and who has exceptional potential for leadership in the profession of engineering and in society.

Also, the Xi chapter of Phi Beta Kappa voted Ian Parrish a membership in the society in recognition of his excellent academic record and commitment to the objectives of a liberal education.

The MIT chapter of the Alpha Nu Sigma society, a national honor society for students in applied nuclear science and nuclear engineering, recognized six graduate students and two undergraduate students for their outstanding academic achievement. The MIT Health Physics Society student branch's activities are focused on environmental radiation transport, radiobiology, and radiation detection and measurement.

A number of students were recognized at the annual international dinner/awards ceremony in May 2002. Li Liu (fall) and Jacopo Saccheri (spring) received the Manson Benedict Fellowship awarded to a graduate student for excellence in academic performance and professional promise in nuclear engineering. Victoria Anderson received the Roy Axford Award for academic achievement by a senior in nuclear engineering. Tanya Burka received the Irving Kaplan Award for academic achievement by a junior in nuclear engineering. Graduate students Virginia Curran and Juliet (Leigh) Outten shared the Outstanding Student Service Award in recognition of exceptional services to the students, the department and the entire MIT community. Graduate students Paola Cappellaro and Bilge Yildiz shared the Outstanding Teaching Assistant Award in recognition of exceptional services to education by a teaching assistant. Selected by the American Nuclear Society's Education and Training Division to receive a 2002 ANS Graduate Scholarship Award were Virginia Curran, Scott Kiff, Karen Noyes, Leigh Outten, and Jacopo Saccheri.

Jeffrey P. Freidberg
Department Head
Professor of Nuclear Engineering

More information about the Department of Nuclear Engineering can be found on the web at http://web.mit.edu/ned/www/.

Department of Ocean Engineering

Perhaps nothing in the earth's landscape captures our imagination as much as the oceans. Full of mystery, beauty, bounty and potential, they also represent the last great frontier for exploration on our planet.

Since its inception, MIT's Department of Ocean Engineering has been committed to educating exceptional students who will take on this gauntlet of discovery. The field of ocean science is exciting, ever changing and challenging, as we learn more each year about the critical role of the seas in areas such as climate change, energy, transportation, global economies and nearly every aspect of our lives.

In the simplest terms, ocean engineering can be defined as the development of engineering systems for use in the ocean. In our department, students examine the complex phenomena of the oceans and develop novel technologies through intensive, hands-on research. In so doing, they also gain a knowledge that fosters the wise use and preservation of these irreplaceable natural resources.

We have set high goals for ourselves for the 21st century, including designing complex systems for high-performance ocean vehicles, leading the information revolution in the ocean, conducting large scale experiments to better understand marine environments, and introducing chemistry and biology into the discipline of ocean engineering. Much of this work draws on earlier research in the department, and much work still lies ahead.

In collaboration with the MIT Sea Grant College Program, our department has revolutionized the design of autonomous underwater vehicles, or AUVs. Such submersibles are now unlocking secrets of the deep oceans for scientists, industry, and national defense. We look forward to a future filled with innovation and discovery, with a keen eye always on sustaining our marine environment and economy.

The mission of the department is:

- To educate and prepare students for leadership positions in industry, government and educational institutions
- To influence future directions of ocean engineering education and practice
- To develop and disseminate knowledge and technology in order to foster and enable the wise and effective use, development, and preservation of the ocean, its natural resources and its environment

The department's major goals over the next ten years are:

- To lead the information revolution in the domain of the oceans
- To lead the application of large scale, complex system design and engineering for high performance ocean vehicles and systems
- To contribute to a better understanding of ocean dynamics through large scale experiments that complement the theoretical and numerical capabilities presently available
- To prepare ground for the next major innovation in the department, which is to introduce chemistry and biology into the discipline of ocean engineering

Accomplishments

MIT's Department of Ocean Engineering is the founding member of the National Naval Engineering Research and Education Consortium (NERC). The mission of the consortium is to develop and execute an effective, sustainable program in naval engineering research and education. NERC is a stakeholder consortium with university, government and industry representation. This is the culmination of work started by Professor Chryssostomidis and Dr. Burke in May 1999.

ABET

The Accreditation Board for Engineering and Technology reviewed the department's undergraduate program and has accredited it for an additional six years.

Discover Ocean Engineering

For the fifth year we offered Discover Ocean Engineering: A Special Introduction to MIT to the Class of 2005. This innovative program for incoming freshmen was set up in 1998 as a four-day program to provide a first glimpse of what engineering is all about. It also allows the students to become familiar with some of the opportunities that the field of ocean engineering has to offer. In addition they get a jump start on becoming involved in campus life and building a close relationship between the students, our faculty and staff.

As in the past, the agenda consisted of hands-on experience building a small remotely operated vehicle (ROV), testing it in the water, and providing a chance to perform some actual research experiments with an ROV in Boston Harbor. This pre-orientation program remains extremely popular among students. It has inspired Discover Mechanical Engineering, spearheaded by Discover Ocean Engineering alumnae. For the summer of 2002 plans for four Discover programs are underway: Discover Civil and Environmental, Mechanical, Nuclear, and Ocean Engineering.

T. Francis Ogilvie Young Investigator Lectureship in Ocean Engineering

In October, 2001, Professor Thomas R. Powers presented the seventh annual T. Francis Ogilvie Young Investigator Lecture. The lecture on bacterial flagellar mechanics described the propulsion mechanics of these complex protein machines, which has many similarities with fish propulsion, an area of research in the department. Professor Powers is the James R. Rice assistant professor of solid mechanics in the Division of Engineering at Brown University.

Robert Bruce Wallace Prize

The winner of the 2002 Wallace Prize, which is awarded to an outstanding undergraduate in the Department of Ocean Engineering, was Angus Kai McDonald. Kai was selected from a list of extremely qualified candidates and will be provided a full academic year of tuition and stipend for FY2003.

Martin A. Abkowitz International Fellowship Program

The following individuals were awarded Martin A. Abkowitz International Fellowships: Dr. Alexandra Techet for her participation in an IUTAM symposium on unsteady separated flows in Toulouse, France; Justin Manley for his upcoming research at the MIT AUV Lab facility in Italy; and Dr. Tom Consi to attend and present a paper at the American Society for Engineering Education (ASEE) annual conference in Montreal, Canada, in June 2002.

Ship Design and Shipbuilding Technology Symposium

On May 8–9, 2002, the Department of Ocean Engineering hosted the annual Ship Design and Shipbuilding Technology Symposium, part of a series of symposia and workshops established in 1986, at the MIT Faculty Club. This symposium is held to establish and maintain positive communication with industry, Navy laboratories and Navy programs on research and education issues relevant to the naval construction and engineering curriculum. Following an introduction by the faculty supervisor, the 13A graduate students presented their theses, and design projects, which as always were very well received. RADM Paul E. Sullivan, deputy commander for integrated warfare systems, Naval Sea Systems Command, was the May 8 banquet speaker. Over 100 people from academia, industry and the government attended this annual event.

Alumni Reunion

The 22d annual Ocean Engineering reunion was held at Disney World in Florida in October 2001. The reunion is traditionally held in conjunction with the Society of Naval Architects and Marine Engineers annual meeting. The 2001 reception was hosted by Professor Chryssostomos Chryssostomidis and was well attended by alumni, faculty and guests.

Administrative Changes

Our administrative officer of many years, Sharon Trohon, was selected for the position of administrative officer at Mechanical Engineering—a well deserved move forward. Her successor, Helen L. Broderick, was hired in December 2001. Eda Daniels was recently hired as admissions coordinator in our Student Administration Office, replacing Tammy Lynch.

As the result of an extensive search for a new faculty member in the area of hydrodynamics, Dr. Alexandra Techet, a former MIT Ocean Engineering student, was hired as the department's newest junior faculty member. Alex will begin her appointment July 2002. This appointment fulfilled the top priority in the department's strategic plan.

The department received funding from the School of Engineering's Dean's Office and the US Navy to assist in the upgrading of the Marine Hydrodynamics Laboratory under the direction of Professor Michael Triantafyllou. In addition, the department provided matching funds for this renovation.

Future Plans

Professor Arthur B. Baggeroer requested and was granted a sabbatical for the spring 2003 semester. His plan is to write a text on matched field array processing. Professor Tomasz Wierzbicki requested and was granted a sabbatical for the academic year 2002–2003. His plan is to collaborate with other laboratories and colleagues working in the area of crashworthiness worldwide.

Professor Chryssostomos Chryssostomidis announced his intention to step down as department head effective September 1, 2002, to more fully devote his energies to research, teaching and to the MIT Sea Grant College Program. Professor Henrik Schmidt has agreed to assume the position of acting department head for the Department of Ocean Engineering.

Faculty Notes

Professor John V. Amy has been instrumental in helping the department develop a coherent program in the area of electric ship propulsion. This represents an important element in the research and education of future Naval officers as the Navy embraces the concept of electric ship propulsion.

Ford professor Arthur B. Baggeroer and Doherty professor Nicholas C. Makris continued their fourth and final

year in the positions of Secretary of the Navy/Chief of Naval Operations (SECNAV/CNO) chair and scholar, respectively.

Dr. David Burke, with the assistance of Erik Millet, support staff, and Christine Salib, an independent contractor, developed a new and upgraded version of the Ocean Engineering web site. Dr. Burke has also assumed the oversight of the new communication requirement for our undergraduates.

Professor Chryssostomidis participated in the Baratti, Italy Expedition, in August 2001 as the MIT AUV team leader. The purpose of MIT's participation in the expedition was to assist our Italian colleagues with underwater navigation.

It is with great regret that I report the death of former department head and dean of engineering Dr. Alfred Keil. A memorial service was held at the MIT Chapel in February 2002 where a number of his colleagues joined with family members to recognize his many contributions to the Institute. In recognition of Alfred's significant contributions to ocean research and education, MIT has established the Alfred A. H. Keil Ocean Engineering Development Fund. The fund will perpetuate Alfred's basic principles and lifelong dedication to broad-based research in ocean engineering, with special emphasis on related societal needs and concerns, by providing financial support where appropriate to undergraduate and graduate students and junior faculty. A biography, *Alfred Keil, Multiple Genius*, has been written by Sea Grant and is available from the MIT Sea Grant College program.

Professor Justin E. Kerwin completed his final year of teaching and student supervision on a 49 percent appointment he received after retiring in 1997.

Professor John Leonard coorganized a workshop on mobile robot navigation and mapping for the ICRA 2002 conference in Washington, DC.

Professor Nicholas C. Makris won the Henry L. and Grace Doherty Professorship of Ocean Utilization in July 2000 for his project "Monitoring Natural and Manmade Ambient Noise in Massachusetts Bay." This is a two-year professorship providing an annual budget of $25,000.

Professor Hank Marcus published *The International Containership Industry and the Increasing Role of the Charter Market* with Jonathan L. S. Byrnes, MIT/Marsoft Conference on Investment and Risk Management, August 2001.

Prior to his retirement, Professor Koichi Masubuchi and the department created a new fund account entitled The Koichi and Fumiko Masubuchi Fund to promote the publication or dissemination of information dealing with the applications of scientific principles and analytical understanding with emphasis on ocean and related engineering disciplines. Preference will be given to the dissemination of information resulting from Japanese and American scholar collaboration in these disciplines. Professor and Mrs. Masubuchi added generously to this fund with the donation of personal property to MIT.

Professors Chip McCord and John Amy organized and successfully conducted seven short courses over a nine-week period for the professional summer program to meet unique Navy educational needs that cannot be met on campus during the regular academic year.

Professor Jerome Milgram began a major experimental program on the forces on autonomous underwater vehicles in shallow waters. This is in response to the Navy's increased interest in operations in the littoral zone.

Professor Nicholas Patrikalakis continues as the Kawasaki professor. He and Dr. Takashi Maekawa published the book *Shape Interrogation for Computer Aided Design and Manufacturing*. The publisher is Springer Verlag.

Professor Henrik Schmidt was the chief scientist for GOATS 2002, a major expedition held in May and June 2002 in the Tuscan Archipelago, Italy. Professor Leonard joined the expedition as the scientist responsible for navigation. A number of Ocean Engineering scientists and students and Sea Grant engineers participated in this highly successful cruise.

Professor Paul Sclavounos is exploring new directions in his research to include nonlinear seakeeping of vessels in littoral waters.

Following the successful 2001 archaeological expedition to the isle of Nisyros, Professor Michael Triantafyllou is preparing the next phase for the department's work in the Aegean Sea. This is in collaboration with the National Technical University of Athens (NTUA), the National Centre for Marine Research of Greece (EKTHE), the Marine Archaeological Agency of Greece, and the Ministry of Culture of Greece.

Professor Kim Vandiver continues with his third year as the dean for undergraduate research. This includes being director of the Undergraduate Research Opportunities Program and director of the Edgerton Center, as well as co-director of the Office of Academic Services.

Professor Tomasz Wierzbicki included a special project in his structural mechanics class (13.014). This special project asked the students to explain the reason for the collapse of the World Trade Center.

Professor Dick Yue continues his service to the Institute as associate dean of engineering with special responsibility for educational programs in the School of Engineering and the Institute.

Student Awards

Benjamin Connell, Jay Dryer, Donald Eickstedt, Ryan Eustice, Justin Harper, Parker Larsen, Stephen Light, Anna Michel, Saul Rosser and Matthew Walter have been awarded or continued to receive the National Defense Science and Engineering Graduate (NDSEG) Fellowship that provides three years of funding towards tuition, stipend and fees.

Anna Michel is also the recipient of the Link Foundation Fellowship to foster ocean engineering and ocean instrumentation research. It provides a grant of $25,000: $21,000 to be used for a year's stipend, $2,500 for research expenses; and $1,000 for publication costs.

Katherine L. Croff received the Dean John A Knauss Marine Policy Fellowship. This fellowship allowed her to spend a year in Washington, DC, working in the Office of Ocean Exploration at the National Oceanic and Atmospheric Administration (NOAA). She was a member of the team that developed NOAA's Ocean Exploration Program.

Presidential Fellowships were provided to Konstantinos Pelekanakis (fall and spring), John Hootman (fall 2001) and Steven Torok (spring 2002). These fellowships are awarded by the Institute and provide one-year funding towards tuition and stipend.

Jessica Donnelly received a $2,000 undergraduate scholarship from the Society of Naval Architecture and Marine Engineers (SNAME) undergraduate fellowship.

John C. Hootman received a $10,000 award from SNAME, and was designated the Kennedy Scholar; Steven W. Torok: received $8,000 also from SNAME and was designated the Richards Scholar; Kwang H. Lee and Justin Harper received $7,000 and $2,000 awards, respectively, also from SNAME.

The American Bureau of Shipping Fellowship was awarded to Timothy W. Glinatsis, a graduate student in the Ocean Systems Management (XIII-B) program.

Timothy Prestero won the MIT Center for Environmental Initiatives Martin Fellowship and the MIT Entrepreneurship Center Carroll L. Wilson Award.

Jonah Elgart, Ian M. McCreery, Jan Meyer, and Ann Polsenberg of Ocean Engineering and John McNally of Mechanical Engineering received the SNAME Undergraduate Paper Honor Prize for their paper presented before the Society's New England section. Their paper described the design of the capstone design project.

Dr Richard Kimball received the SNAME Graduate Paper Honor Prize for his paper describing his doctoral dissertation on numerical propeller hydrodynamics.

Anna Michel placed third in the student poster competition at the Marine Technology Society (MTS) conference.

Kyle Becker and Joshua Wilson won the first and third prize, Student Paper Award, Acoustical Oceanography, ASA meeting, respectively.

Purnima Ratilal won the first prize, Student Paper Award, Underwater Acoustics, ASA meeting.

Teaching and Curriculum

13.012 Hydrodynamics for Ocean Engineers introduces the principles of fluid mechanics and applies them to practical ocean engineering problems. The fundamental properties of a fluid are investigated and the basic governing equations of fluid motion are derived in differential and integral form. Hydrostatic equations and vessel stability are discussed in the context of surface and underwater vessels. Basic flows past cylinders, spheres, flat plates and hydrofoils are used as a platform for understanding the more complex flows often found in ocean engineering and naval architecture applications.

A number of new experimental projects have been added to 13.012 to help illustrate concepts taught in class, including ship resistance and model testing, lift and drag forces on submerged bodies, and vehicle propulsion. Weekly lab sessions will be supplemented by practical problem sessions and demonstrations. Laboratory sessions are geared towards demonstrating proper data collection and analysis as well as writing clear and concise lab reports. Statistical data analysis, time series analysis, error estimation, and dimensional analysis will be discussed in the context of each lab to help students prepare for their own future research and engineering careers.

Laboratory exercises closely follow the syllabus of the subject and demonstrate physical phenomena in a hands on fashion. Interactive demonstrations help students further understand hydrodynamic stability, fluid viscosity, hydrostatic pressure as well as pressure in a moving fluid. Several laboratories are designed to demonstrate basic principles and flow features present in common ocean engineering problems. Such laboratory exercises include basic flow around circular cylinders, vortex-induced vibrations, lift and drag versus angle of attack of a hydrofoil, ship resistance and model testing, and propeller thrust and cavitation

13.019 Computational Techniques for Structural Design was offered for the second time in spring 2002. The subject introduced the loading mechanisms on ocean structures and the theory of plates and shells in the context of marine structures. Projects were completed demonstrating ability to develop computer analyses and use of advanced industry computer applications to make design evaluations. Ability to check the application tools results by hand or with simple derived computer routines was emphasized. The subject was very well received by the students.

Subject 13.49 Maneuvering and Control of Surface and Underwater Vehicles was transitioned to the internet in the fall semester of 2000. During 2001 the material posted on the internet was constantly refined and in fall 2001 was taught in its new form with great success. A dedicated, password-protected server has been set up to post lecture notes and revisions, and homework exercises and solutions. In addition, we developed the capability for students to perform time/domain simulation and linear controller design over the web using the Matlab web server. This feature is especially useful for learning about control of dynamic systems without becoming bogged down in the specific syntax of advanced controller design in Matlab.

Research Activities

Professors Baggeroer, Milgram and Schmidt successfully competed for funding under a new three-year ONR DRI entitled Capturing Uncertainty to further develop the fundamental understanding of the relative significance of the various oceanographic and geophysical uncertainty properties to the sonar performance statistics.

Professor Chrys Chryssostomidis was the chief scientist of a ten-day expedition to Argentario, Italy. An autonomous underwater vehicle (AUV) was used to explore the ocean bottom for archaeological artifacts. During the Argentario expedition, the ocean bottom near Elba and Argentario was mapped using side-scan sonar. At present the massive amount of data collected during the expedition is being analyzed for images of archaeological interest. Our longterm research objective is to ground truth side-scan sonar records with visual images and start building a library of sonar targets with visual comparisons that will help future explorers identify interesting targets. Some visual images were collected by our Italian colleagues using cameras mounted on remotely operated vehicles.

Professor Nicholas Makris continues his work in a variety of fields including acoustic detection and classification of hurricanes; spectral formulation for the Doppler-shifted field scattered by an object moving in a stratified medium; reverberation and submerged target scattering in shallow water, geological clutter experiments and a search for an ocean on Europa. He has also led a very successful ONR-sponsored expedition, which confirmed that buried river channels are the primary cause of geo-clutter.

Professor John Leonard continued with the development of decoupled stochastic mapping (DSM) and initiated a new project under funding from Draper Labs for extension of the approach to multiple robot navigation. The goal is for several vehicles to cooperatively perform concurrent mapping and localization (CML). In addition, he is working on real-time implementation of CML onboard an autonomous underwater vehicle (AUV).

Professor Nicholas Patrikalakis continued with his Solid Freeform Fabrication (SFF) research, a major NSF and ONR project which has as its objective the development of a generalized solid modeling method for SFF, providing support for design, representation, visualization, and manufacture of solids with local composition control (LCC), which is not possible in today's CAD/CAM systems. In the CAD area, Professor Patrikalakis works on two additional NSF-funded projects. The first relates to the intrinsic watermarking of solid bounded by sculptured surfaces, thereby providing a method for object identification and ownership protection in an electronic environment. The second project relates to robust intersection algorithms and rectification of CAD models to allow their correct interpretation during translation from one CAD system to another. In addition, Professor Patrikalakis based on early work on his NOAA-funded project, Poseidon: A Coastal Zone Management System over the World Wide Web, initiated research on a new major NSF/ITR project, also under the name Poseidon, for rapid real time interdisciplinary ocean forecasting in a distributed computing environment focusing on adaptive sampling and adaptive modeling aspects of the problem.

Professor Henrik Schmidt's research on the multi-static active acoustics project, is to develop fundamental understanding of the acoustic environment of the seabed, and to develop new numerical models of the 3D scattering by seabed objects, such as mines and hazardous waste containers, on and below the seabed in shallow water. Closely tied to the multi-static acoustics effort is the Generic Ocean Array Technology Sonars (GOATS), a new system concept for acoustic observations in the ocean environment, replacing the traditional hardwired hydrophone arrays. This is done by a virtual array of small underwater vehicles each equipped with a small aperture array, and linked together by high-bandwidth acoustic or optical links. GOATS is envisioned as the enabling technology which with the new 3D modeling capabilities can be synergized into an entirely new sonar concept for mine counter measures and undersea warfare in shallow water. A very successful GOATS 2002 was just completed this spring.

Professor Michael Triantafyllou, among several other projects, has completed the first period of research funded by Sea Grant and partially by NAVSEA, on the development of a biomimetic underwater vehicle, capable of swimming in strong currents and large waves, thanks to fish-like flapping fins. A fin-based actuator has been designed and constructed that produces large forces rapidly. This is the first of several such fins that are needed for the vehicle, which will have many uses for oceanographic, reconnaissance, and archeological work underwater.

Professor Tomasz Wierzbicki continues to lead the highly successful Impact and Crashworthiness Laboratory in the department. Professor Wierzbicki's laboratory in addition to the highly successful research in automobiles has embarked in a new area of research dealing with structural failure due to extreme loads. His most recent research in this area deals with development of blast resistant adaptive sandwich structures.

Chryssostomos Chryssostomidis
Department Head
Henry L. and Grace Doherty Professor in Ocean Science and Engineering

More information about the Department of Ocean Engineering can be found on the web at http://oe.mit.edu/.

Biological Engineering Division

The Biological Engineering Division (BE), formerly the Division of Bioengineering and Environmental Health, continues to grow in terms of top quality faculty and student numbers, innovative educational programs, and forefront research programs in pursuing its mission of fostering MIT education and research fusing engineering with biology.

Our formal Institute mission statement is to organize education and research at the interface of engineering with biology, with special emphasis on biomedical engineering, pharmacology, and toxicology, and our aim is to define and lead the new biology-based engineering discipline which we term biological engineering.

The central premise of BE is that the science of biology will be as important to technology and society in the next century as physics and chemistry have been in the previous one. Therefore, to translate the revolution in modern biology into a corresponding revolution in biology-based technologies, a new biology-based discipline of bioengineering must be established. We are endeavoring to educate engineers and scientists who can apply their measurement and modeling perspectives to understanding how biological systems operate, especially when perturbed by genetic, chemical, mechanical, or materials interventions, or subjected to pathogens or toxins, and apply their design perspective to creating innovative biology-based technologies in medical diagnostic, therapeutic, and device industries, as well as in non-health-related industrial sectors such as agriculture, environment, materials, manufacturing, and defense. This should lead to a new generation capable of solving problems using modern biotechnology, emphasizing an ability to measure, model, and rationally manipulate biological systems.

The current BE faculty members (with other MIT affiliations noted in parentheses) are Peter Dedon, William Deen (Chemical Engineering), Forbes Dewey (Mechanical Engineering), Bevin Engelward, John Essigmann (Chemistry), James Fox, Linda Griffith (Chemical Engineering), Alan Grodzinsky (Electrical Engineering and Computer Science and Mechanical Engineering), Neville Hogan (Mechanical Engineering and Brain and Cognitive Science), Ian Hunter (Mechanical Engineering), Darrell Irvine (Materials Science and Engineerng), Roger Kamm (Mechanical Engineering), Alex Klibanov (Chemistry), Robert Langer (Chemical Engineering), Douglas Lauffenburger (Chemical Engineering and Biology), Harvey Lodish (Biology/Whitehead Institute), Scott Manalis (Media Arts and Sciences), Paul Matsudaira (Biology/Whitehead Institute), Leona Samson, Ram Sasisekharan, David Schauer, James Sherley, Peter So (Mechanical Engineering), Steven Tannenbaum (Chemistry), William Thilly, Bruce Tidor (Electrical Engineering and Computer Science), Dane Wittrup (Chemical Engineering), Gerald Wogan, and Ioannis Yannas (Mechanical Engineering and Materials Science and Engineering). In addition, Angela Belcher (Materials Science and Engineering), Jongyoon Han (Electrical Engineering and Computer Science), and Matthew Lang (Mechanical Engineering) will be joining the BE faculty during the coming 2002–2003 academic year as they arrive on campus.

Dalia Gabour is our new academic administrator, coming from the position of assistant director of educational services in the Sloan School of Management, replacing Debra Luchanin (who has moved to the position of assistant director of the Financial Technology Option program in the Sloan School). Rolanda Dudley-Cowans continues to serve as our administrative officer.

During fiscal year 2002, the sponsored research volume officially administered within BE was $6.9 million, representing a 19 percent increase over FY2001. It is important to note that this figure represents only those sponsored projects formally assigned to the division; most BE faculty members additionally operate sponsored research projects supervised administratively within other departments and centers; these include the Biotechnology Process Engineering Center, Center for Biomedical Engineering, Center for Environmental Health Sciences, and Division of Comparative Medicine, all of which are directed by BE faculty members (Douglas Lauffenburger, Alan Grodzinsky, Leona Samson, and James Fox, respectively).

The major research areas within BE include: biological and physiological transport phenomena; biological imaging and functional measurement; biomaterials; biomolecular engineering and cell and tissue engineering; computational biology and bioinformatics; discovery, design and delivery of molecular therapeutics; genetic toxicology; macromolecular biochemistry and biophysics; metabolism of drugs and toxins; microbial pathogenesis; carcinogenesis; biomechanics; molecular epidemiology and dosimetry; molecular pharmacology; genomics, proteomics, and glycomics.

A special highlight of this past year was the first annual BE retreat. More than 150 faculty, graduate students, and staff gathered at Ocean Edge Resort on Cape Cod for a weekend away from campus. An extraordinarily stimulating and enjoyable time of science/engineering discussion and social interaction was had by all! Heartfelt appreciation goes to Leona Samson, Olga Parkin, Christiana Struve, and Kevin Janes for their leadership organizational efforts.

Undergraduate Education

BE continues to administer two SB minor programs, in Biomedical Engineering (BME) and in Toxicology and Environmental Health (Tox/EH). In addition, it administers a five-year MEng program in Biomedical Engineering (Bioengineering track). In June 2002, we had 50 graduates with the BME minor, 11 graduates with the Tox/EH minor, and four graduates with the BME/BE MEng. Unusually for School of Engineering programs, the aggregate population of these graduates represents women in the majority.

An especially exciting and important new undergraduate subject was introduced this past academic year, under the direction of Professor Bevin Engelward: BE.109 Laboratory Fundamentals in Biological Engineering. In this subject, students gained hands-on experience with experimental techniques and quantitative analysis methods, including internet database approaches, related to forefront topics in biotechnology.

Graduate Education

BE continues to operate two PhD programs, in Bioengineering and in Toxicology, along with SM programs in the same two fields. The Toxicology program graduated five PhD and three SM students this past year, and the current enrollment is 41. The Bioengineering program was established only three years ago, so it still awaits its first cohort of graduates, although two students finished with SM degrees this past year; the current enrollment is 38. As with the BE undergraduate programs, our graduate student population represents women and men in roughly equal numbers.

BE has been the grateful recipient of wonderfully generous gifts for graduate student fellowships, most notably from Andrew and Edna Viterbi for Viterbi Graduate Fellowships in computational biology and bioinformatics, and from Gordon and Adele Binder for Binder Graduate Fellowships in molecular and cell bioengineering. Additionally, we have received financial support for graduate fellowships from the Medtronic Foundation, the duPont/MIT Alliance, the Merck/MIT Partnership, and the Whitaker Foundation.

Faculty Notes

Angela Belcher received the World Technology Award in materials and was named among *Technology Review*'s TR 100 Top Innovators.

John Essigmann was named Leitch professor in residence for Simmons House.

James Fox was named to serve on the National Advisory Research Resources Council of NIH.

Linda Griffith was promoted to the rank of full professor and became the deputy director of the Biotechnology Process Engineering Center.

Darrell Irvine received the Karl van Tassel Career Development Chair in biomedical engineering.

Roger Kamm was named a Cambridge-MIT Institute Fellow.

Robert Langer received the Charles Stark Draper Award from the National Academy of Engineering, and the Harrison Howe Award from the American Chemical Society.

Douglas Lauffenburger received the William H. Walker Award from the American Institute of Chemical Engineers and served as chair for the College of Fellows of the American Institute of Medical and Biological Engineering.

Harvey Lodish was elected president of the American Society of Cell Biology.

Scott Manalis received a Presidential Early Career Award for scientists and engineers and was named among *Technology Review*'s TR 100 Top Innovators.

Paul Matsudaira was named a Cambridge-MIT Institute Fellow.

Leona Samson became director of the Center for Environmental Health Sciences.

James Sherley was inducted into the Pew Scholars Science and Society Institute Leadership and Policy Program.

Gerald Wogan was appointed senior research fellow for the Laboratory for Human Carcinogenesis at the National Cancer Institute.

Douglas A. Lauffenburger, Co-Director and Professor of Biological Engineering, Chemical Engineering and Biology
Steven R. Tannenbaum, Co-director and Underwood Prescott Professor of Toxicology

More information about the Biological Engineering Division can be found on the web at http://web.mit.edu/be/.

Engineering Systems Division

The academic year 2001–2002 was a one of significant accomplishment for the Engineering Systems Division (ESD) as we continued to move forward toward our goals of defining and evolving engineering systems as a new field of study and transforming engineering education and practice.

The faculty of ESD continued to expand. We are delighted to announce that the following have joined ESD's faculty and teaching staff:

George E. Apostalakis, PhD, received a joint appointment as professor of nuclear engineering and engineering systems in 2002. Professor Apostalakis's research interests include methods for probabilistic risk assessment of complex technological systems; risk management involving several stakeholder groups; decision analysis, human reliability models; organizational factors and safety culture; software dependability; risk-informed, performance-based regulation. His teaching interests include probability and its applications to risk assessment and reliability; risk-benefit analysis; and nuclear reactor safety.

Randolph E. Kirchain, PhD, received a dual appointment in 2002 as assistant professor in the Department of Materials Science and Engineering and the Engineering Systems Division. Professor Kirchain's research focuses on the resource intensity of the materials economies, including the robustness of material recovery infrastructures.

Seth Lloyd, PhD, received a joint appointment in 2002 as professor of mechanical engineering and engineering systems. Professor Lloyd was appointed full professor in 2002 and a principal investigator at the Research Laboratory of Electronics. Professor Lloyd has performed seminal work in the fields of quantum computation and quantum communications, including proposing the first technologically feasible design for a quantum computer, demonstrating the viability of quantum analog computation, proving quantum analogs of Shannon's noisy channel theorem, and designing novel methods for quantum error correction and noise reduction.

Christopher L. Magee, PhD, received a dual appointment as professor of the practice of engineering systems and mechanical engineering in late 2001. He is also director of the Center for Innovation in Product Development. Among Chris Magee's areas of expertise are vehicle design, systems engineering, application of computer-aided engineering and computer-aided design. The application of materials, vehicle crashworthiness, manufacturing product interface and all aspects of the product development process are also areas of significant personal experience and knowledge.

Frank R. Field, III, PhD, received an appointment as senior lecturer in engineering systems in 2001. He is also affiliated with the Materials Systems Laboratory and is senior research associate, the Center for Technology. Policy, and Industrial Development (CTPID), associate director of education, Technology and Policy Program (TPP), and senior research engineer.

Daniel Whitney, PhD, senior research scientist, CTPID, received an appointment as senior lecturer in engineering systems in 2001. His interests include agile manufacturing, the use of computers in product design, understanding the role of assembly in the design and manufacturing process, and understanding how companies decide what design and manufacturing skills and facilities are core competencies. In 2002, he received MIT's silver Infinite Mile award for institutional bridging, to honor his achievements in spearheading successful collaborations students, faculty, staff, and different departments within MIT, as well as with external companies and organizations.

In September, ESD offered its first post doctoral associate position to a Technology, Management, and Policy graduate, Brian Zuckerman, PhD. Brian's work this year involved working with ESD faculty to develop the context for the ESD PhD degree program, as well as a redesign of the curriculum of ESD.10 Introduction to Technology and Policy. Brian also taught the last segment of the course. He produced a paper with Professor Daniel Hastings for the MIT internal symposium that used multiple disciplinary perspectives and analytical tools to analyze the national missile defense issue. Finally, he is working closely with Professor George Apostolakis and a group of other ESD professors to frame an approach to addressing counter-terrorism issues.

Currently, there are 36 faculty appointed—29 in engineering and seven in management. As a division, ESD establishes an intellectual home for key programs and centers, engages faculty across departments and disciplines, and fosters discourse about engineering innovation, all oriented around the issues of engineering systems.

The division coordinates academic programs with some 350 graduate students. The Leaders for Manufacturing, System Design and Management, Transportation, and Technology and Policy programs award master's degrees. PhDs are offered in Transportation and in Technology, Management, and Policy.

This year the division started a small pilot PhD program in engineering systems, which will be run as an interdisciplinary program. Four students were admitted. The ESD faculty and students will use this pilot to try out ideas for the full ESD PhD, which will be presented to the faculty next year.

ESD has four affiliated research centers: the Center for Technology, Policy, and Industrial Development;

the Center for Transportation Studies and Logistics; the Industrial Performance Center; and the Center for Innovation in Product Development. These are described later in this report.

Ongoing Initiatives

Engineering Systems Learning Center

The Engineering Systems Learning Center (ESLC), which was established in AY2001, serves as a repository and enabler for cases, simulators, and other educational material on complex systems. Executive director Joel Cutcher-Gershenfeld has been working with Professor John Williams, ESLC staff member Betty Barrett, and many others in launching the electronic delivery system. Strong interest has been expressed by Cambridge University, under the auspices of the Cambridge-MIT Institute to partner with the ESLC in this process.

Work continues on the Sloan Foundation grant, with Richard de Neufville and Joel Cutcher-Gershenfeld as co-PIs, in the development and delivery of what are being termed "Industry Engineering Systems Studies" for the auto, pharmaceutical, airline and aerospace industries. The resulting products will eventually become accessible online to a wide audience and used for instruction at MIT, other universities and in industry.

Engineering Systems Knowledge Network

A number of ESD faculty and staff are involved in activities of the Cambridge-MIT Institute (CMI). In particular, the CMI Professional Practice Program (PPP), directed by Daniel Roos on the MIT side, has a number of initiatives with strong links to ESD. The CMI PPP represents a portfolio of educational offerings targeted at graduate students and practitioners. Many are modeled after existing MIT programs, such as the Technology and Policy Program (TPP). With a collaboration that began in the summer of 2000, TPP is the most advanced of the PPP efforts.

Other ESD faculty are involved in joint curriculum development with Cambridge University colleagues to create case studies and other educational materials, and to develop modules, executive education, lifelong learning courses, and other degree programs, including a program modeled on MIT's Master of Engineering in Environmental Engineering. These activities complement the mission of the ESD Engineering Systems Learning Center (ESLC), and many synergies are beginning to be explored. The ESLC is well situated to serve as a central repository and sharing mechanism for a wealth of case studies and curriculum materials developed by CMI-funded efforts in addition to the existing ESD efforts. ESLC is coordinating its efforts with other work at MIT on electronic storage—namely, D-Space, Sloan space, etc.

New Undergraduate Systems Minor Planned

Professors Joseph Sussman and Deborah Nightingale led an ESD committee which developed the concept of a minor. The minor will broaden the engineering discipline-specific education in individual department majors to include systems thinking, design, and analysis. The minor will address the multiple aspects of engineering. The ESD faculty approved the minor in January and work is underway to develop the core courses.

Engineering Systems Symposium Committee

The Engineering Systems Symposium Committee, cochaired by Tom Allen and Joel Moses, led a symposium in late May that was attended by about 60 ESD-affiliated faculty, staff and students. The goal of the symposium was to discuss the intellectual foundations of engineering systems. There were 31 presentations at the symposium and a proceedings containing 28 papers was issued prior to the meeting. Key intellectual areas that were identified for furtehr research were product development and system architecting, security and safety as system properties, flexibility, uncertainty and risk, sustainability, and systems theory and complexity.

The symposium was so successful that the ESD faculty decided to have a major international symposium next year.

Faculty Notes

Lean Enterprise Value was published (with Thomas J. Allen, Earll Murmann, Kirk Bozdogan, Joel Cutcher-Gershenfeld, Hugh McManus, Deborah Nightingale, Eric Rebentisch, Tom Shields, Fred Stahl, Myles Walton, Joyce Warmkessel, Stan Weiss and Sheila Widnall) by Palgrave.

Professor Thomas J. Allen received an honorary doctor of engineering management degree from Universitat Ramon Llull, Spain.

Professor George E. Apostolakis was reelected chairman of the statutory advisory committee on reactor safeguards of the US Nuclear Regulatory Commission effective January 1, 2002. He continues to serve on the International Nuclear Technology Committee that advises the governments of three German states (Baden-Wurttemburg, Bavaria, and Hesse) on nuclear technology matters. He was reelected secretary of the International Association for Probabilistic Safety Assessment and Management. He continues to serve as the editor-in-chief of the international journal *Reliability Engineering and System Safety*. He chaired the independent peer-review panel that reported to senior NASA management on the probabilistic risk assessment of the international space station. He was an invited speaker at the fourth national symposium on space system risk management sponsored by the Aerospace Corporation and the Air Force Space and Missile Systems Center. He was an invited panelist at the workshop *Performance-Based Regulation: Prospects and Limitations in Health, Safety, and*

Environmental Protection sponsored by the John F. Kennedy School of Government of Harvard University.

Professor Cynthia Barnhart, codirector of the MIT Operations Research Center since 1999, was promoted to professor on July 1, 2001. She was also named codirector of the Center for Transportation and Logistics, with her appointment taking official effect on September 1. As codirector with Yossi Sheffi, who has led the center since 1991, Barnhart's primary responsibility is to supervise the educational programs associated with the center—the nine-month Master of Engineering in Logistics program (MLOG), the two-year Master of Science in Transportation program (MST), and the PhD program in transportation. (Barnhart is, herself, an alumna of the last two programs.)

Professor Richard de Neufville was a visiting scholar at Cambridge University and lifetime fellow at Clare Hall. While there, he taught at the Judge Institute of Management and helped to get the Cambridge version of the Technology and Policy Program off the ground. He also received an honorary doctorate from the Technical University of Delft.

Professor Thomas W. Eagar received General Electric's Distinguished Lecturer Award.

Rensselaer Polytechnic Institute professor Steven D. Eppinger completed his term as co-director of CIPD and assumed the role of co-director of LFM-SDM in June 2001. He is a half-time faculty fellow with the Singapore-MIT Alliance and has been working on sponsored research programs with the Ford-MIT collaboration, SMA, and CIPD. His paper for the ASME Design Theory and Methodology Conference received the Xerox Best Paper Award in September 2001. The second edition of his textbook *Product Design and Development* (McGraw-Hill, 2000, with Karl Ulrich) has been translated into three foreign languages. The book is used by more than 150 universities in the United States, plus many overseas.

Professor Daniel Hastings, director of the Technology and Policy Program and professor of aeronautics and astronautics and engineering systems, was appointed associate director of Engineering Systems Division. Professor Hastings will oversee all of the educational initiatives within ESD. He succeeds Professor Paul Lagace. Professor Hastings was also appointed as the chair of the Air Force Scientific Advisory Board. He gave the final keynote address at the 50th anniversary celebration of the Air Force Office of Scientific Research.

Professor Randoph Kirchain published several papers, among them "Assessing the Strategic Value of Manufacturing Technology through Process Based Cost Modeling" (with Rich Roth, Frank Field, and Joel Clark), in *Business Briefing Publications – Global Automotive Manufacturing Technology*, World Markets Research Centre, London, England.

Professor David H. Marks was named head of MIT's new Laboratory For Energy and the Environment (a merger of the Energy Lab and the Center for Environmental Initiatives), which was formed on July 1, 2001. He was also appointed as Chalmers honorary doctor, May 2002. His research includes large infrastructures from economic and environmental perspectives. He has also been actively involved in the creation of Chalmers Environmental Initiative.

Professor Fred Moavenzadeh, James Mason Crafts professor of engineering systems, published *Future Cities: Dynamics and Sustainability* (Kluwer Academic Publishers). The US Army Corps's chief of engineers, Lieutenant General Robert Flowers, awarded Professor Fred Moavenzadeh the Bronze Order of the deFleury Medal on May 15, 2001. Professor Moavenzadeh also presented at the Boston Post Army Corps of Engineers meeting (Engineers without Borders) and in Mexico City at the United Nations Development Program for Technology in Social Development.

Professor Joel Moses was named chancellor's distinguished lecturer at the Louisiana State University in January, 2002.

Professor Earll Murman was elected a fellow of the Royal Aeronautical Society and received the Department of Aeronautics and Astronautics undergraduate advising award.

Professor Deborah Nightingale succeeded department colleague Professor Earll Murman, as Lean Aerospace Initiative codirector. Nightingale shares leadership responsibilities with Professor Tom Allen, MIT Sloan School of Management, and a third codirector from industry to be determined, a role most recently held by former Boeing executive Fred Stahl.

Professor Yossi Sheffi made several presentations. These included: "Combinatorial Procurement," at the Wharton Business School; "The Effect of the Internet on Supply Chain Management," at MIT's Technology Day in Tokyo, Japan; "The Effects of Terrorism on Supply Chain Management," at the CLM event at Cranfield Business School, England; and "The Impact of Technology on Supply Chain Management," at the World Economic Forum in New York City. He also taught an executive summer course in supply chain management and a CMI course in supply chain management (with David Simchi-Levi and a Cambridge faculty member, Duncan McFarlane); and published a paper in the International *Journal of Logistics Management* titled, "Supply Chain Response to Terrorism."

Professor David Simchi-Levi, together with Professor Charlie Fine from Sloan, established the "MIT Forum

on Supply Chain Innovation" with funding from SAP and committed funding from British Telecom. His book *Designing and Managing the Supply Chain* (with P. Kaminsky and E. Simchi-Levi, Irwin/McGraw-Hill, IL, 1999) was selected in the December 2001 issue of *Business 2.0* as the best source for slashing time and cost and increasing productivity in the supply chain. In 2001, the book was translated to Chinese, Japanese and Korean. The second edition of the book is scheduled for publication in October 2002.

Professor Joseph M. Sussman received the Transportation Research Board's Roy W. Crum Award, its highest honor, in January 2002. Sussman was honored for his significant contributions to research on railroads, intelligent transportation systems, and other large integrated systems. The Intelligent Transportation Society (ITS) of Massachusetts, the state chapter of ITS America, established the Joseph M. Sussman Leadership Award in April 2002. It was created in recognition of Professor Sussman's contributions to, and leadership in, the Massachusetts and national intelligent transportation systems field. This annual award is intended to honor sustained leadership performance in this arena. In addition, Professor Sussman won the MIT Technology and Policy Student Society Faculty Appreciation Award for 2002 for his work in subject ESD.10, a new introductory required subject in technology and policy.

Major Meetings

Sustainable Mobility: Global Challenges for the 21st Century

On May 3, 2002, TPP hosted this symposium on transportation issues in developing and developed countries. The event was cosponsored with TPP, ESD, the Laboratory for Energy and the Environment, the US Department of Transportation, and the World Business Council for Sustainable Development.

Norman R. Augustine, former president, CEO, and chairman, and current chairman of the executive committee of Lockheed Martin Corporation, spoke at the inaugural Brunel Lecture Series on complex systems. The title of his presentation was "Simple Systems and Other Myths." This event was sponsored by ESD.

Professor Sir Alec Broers, vice chancellor, Cambridge University, Cambridge, England, spoke at the inaugural Charles L Miller Annual Lecture. His topic was "Insight or Invention? The Need for Collaboration in High Technology." The event was cosponsored by the Cambridge-MIT Institute, MIT Department of Civil and Environmental Engineering, and MIT Engineering Systems Division.

Dr. Gerald Yonas, vice president and principal scientist, Sandia National Laboratories, spoke on "Sandia's Thoughts on the War on Terrorism." The event was cosponsored by ESD, CTPID, LFEE, TPP and Sandia National Laboratories.

Tom Burbage, executive vice president and general manager, Joint Strike Fighter, Lockheed Martin Aeronautics Company, spoke on "Creating and Maintaining a Winning Environment." This event was cosponsored by ESD and the student section of the American Institute of Aeronautics and Astronautics.

Daniel Roos
Director
Japan Steel Industry Professor of Engineering
Professor of Civil and Environmental Engineering and of Engineering Systems

More information on the Engineering Systems Division can be found on the web at http://esd.mit.edu/.

Technology, Management, and Policy

The Technology, Management, and Policy Program (TMP) is an interdisciplinary PhD program directed at producing world-class researchers striving to improve methods used in defining and implementing policies for the intelligent use of technology.

The program was established in 1992 and became a part of the Engineering Systems Division in 1998. The students within the program are motivated by their recognition of specific problems at the boundaries between technological development and social and industrial policy. The goals of the TMP program are to supply an academically rigorous environment within which these students, under the guidance of MIT faculty, work to extend the nature and purview of the tools needed to understand and address these issues.

The common vision of the program participants is that a dual competency in a technical area and in management and policy is the basis for the effective design of large-scale systems. The research efforts within the program are leading to the development of a new paradigm for the planning and design of engineering systems—a paradigm that blends technical expertise with competence in economics, management, and policy to achieve a better adaptation of technology to societal goals.

Students are not directly admitted to the program; rather, they are first admitted to the master's program in technology and policy. After their arrival at MIT, these potential TMP students then prepare a case for admission to the TMP program, which requires that they construct an appropriate research question; assemble a cadre of MIT faculty committed to that effort, and develop a proposed curriculum that will assure that the student will be equipped to address this question in a manner consistent with the highest academic standards of the fields represented. This

admission case is then reviewed by the TMP admissions committee, composed of faculty drawn from the MIT Schools of Engineering; Management; and Humanities, Arts, and Social Sciences.

Although the majority of the students in the program initially came to TPP solely for the SM in technology and policy, many of our students pursue a simultaneous second SM or doctorate in another discipline. There has also been an upsurge in applicants who have specifically targeted admission to TMP over the past three years.

The program generally admits about five students each year, but eight students were admitted to TMP this past year. Students take approximately five years to complete their degrees and there currently are 19 students enrolled in the TMP program. Six TMP PhDs were awarded this year, and these graduates have joined their 24 colleagues in careers in industry, academia, and government.

Marvin and Joanne Grossman have recently made funding available to help doctoral students travel to exchange ideas with doctoral students in programs with a similar mission to TMP's. This year, two students have just returned from the first international doctoral consortium in Delft, The Netherlands, where they gave papers and interacted with students from other programs. We look forward to using this funding to help our students to exchange information with other students who have similar goals and interests.

Daniel Hastings
Director
Professor of Aeronautics and Astronautics and of Engineering Systems

More information about the Technology, Management, and Policy Program can be found online at http://mit.edu/tpp/www/.

Technology and Policy Program

The MIT Technology and Policy Program (TPP) provides an integrative education to scientists and engineers who wish to lead in the development and implementation of responsible strategies and policies for exploitation of technology for the benefit of their communities. TPP's guiding vision is the education of leaders who are engineers and scientists.

The Technology and Policy Program graduate educational program in the School of Engineering acknowledges that the development of the skills necessary for effective implementation of technology tie into the emerging engineering systems educational thrusts and, consequently, TPP is part of the Engineering Systems Division of MIT. The program focuses on providing a high impact, high quality education to its students. Its goal is to make TPP the most prestigious and sought after technology policy program in the world and to produce the technological decision makers of the future.

TPP sponsors both a master of science program and the technology, management and policy (TMP) doctoral program. TPP receives most of its applications from outside MIT, but also has several internal admits each year, with students pursuing dual master's degrees simultaneously. Approximately, 35 percent of the students are pursuing dual degrees.

This year, 36 students graduated with master's degrees in technology and policy, and eight master's students were accepted to continue their studies at the doctoral level. Six doctoral students graduated during AY2002. This year's best thesis in technology and policy was awarded jointly to Ralph Hall and Natalia Ramirez. The TMP program has a current enrollment of 20 students, reflecting a steady-state admission rate of about five students per year. Seven students received their technology, management and policy PhD in June 2002.

One-semester fellowship funding was provided to five incoming students, with partial funding provided to a sixth. This funding, which includes the Rabinowitz and deNeufville funds, has been provided by TPP alumni and donors, who make possible several other student benefits.

Samudra Vijay and Serena Chan received the Grossman award and will be using it to attend a conference at TU Delft, where they have been selected to present papers. In addition, through alumni and donor funding, the Technology and Policy Program sent seven master's and doctoral students to Carnegie Mellon University to discuss their research, and sent another seven to the AAAS conference in Washington, while funding one of the many TPP students who attended the AGS conference in Costa Rica.

The Technology and Policy Program greatly values practical experience and actively encourages students to take summer internships between their first and second years of study. In January 2002, eleven students traveled to Washington, DC to attend meetings with prospective internship employers. Partly as a result, many of our students found internships in Washington. Students whose internships were unfunded were able to take advantage of funding provided by TPP alumni and donors, including Larry Linden and Phillip Ng, in order to make their internship experiences possible.

This past year, the new subject ESD.10 was team taught by Professors Sussman, Hastings, Field, Oye, and others. Some additional fine tuning will be possible for next year, through the availability of curriculum development funds from the Lord Foundation. Professor deNeufville returned from his sabbatical with a revised ESD.71 curriculum. Student response to these two revised courses was enthusiastic, leading to Professors Sussman and deNeufville being voted the Faculty Award by the TPP students. Professor Ashford won the first award in 2001.

The Technology and Policy Program has continued to work with the Cambridge-MIT Institute, and several faculty members traveled to Cambridge University this past year to participate in teaching several new courses. Cambridge University will admit full-time students to its nine-month program starting this fall.

The annual event this year was the Sustainable Mobility Symposium, held in May. This was well attended by students and outside participants. TPP also cosponsored two events with colleagues at Harvard University on issues of nuclear weapons policy and energy policy.

Daniel Hastings
Director
Professor of Aeronautics and Astronautics and of Engineering Systems

More information about the Technology and Policy Program can be found online at http://mit.edu/tpp/www/.

Leaders for Manufacturing

The Leaders for Manufacturing (LFM) program is a partnership between MIT and over 25 global manufacturing firms to discover and translate into teaching and practice principles that produce world-class manufacturing and manufacturing leaders. This partnership is motivated by our shared belief that excellence in manufacturing is critical to meeting the economic and social needs of individuals, firms, and society, and that the health of companies operating in global markets is essential to society's well-being.

Now, in its 13th year of operation, LFM is a partnership between the School of Engineering, the Sloan School of Management, and leading manufacturers. Launched in 1988 with significant industry funding, the program emphasizes collaboration and knowledge-sharing with its partner companies across the entire spectrum of "Big-M" manufacturing enterprise issues. LFM supports students as fellows in the program with fully paid tuition. The largest component of the educational efforts is the Fellows Program, a 24-month dual master's degree (SM in engineering and MBA or SM in management) experience involving a single integrative research project carried out on-site in partner firms.

Academic Programs

Forty-seven students in the class of 2002 completed the Fellows Program and approximately 80 percent have taken positions in manufacturing firms. Each of the 47 graduates completed an internship at a partner company during the summer and fall of 2001. Internships are focused projects of concerns to the partners, accomplished by interns with company support and MIT faculty guidance. Representative projects this past year included the use of modeling and critical operations data to optimize plant performance, applying lean manufacturing techniques for the design of an aircraft assembly line, and supply chain performance through forecasting.

Another 48 students (class of 2003) completed their first year of on-campus studies and are starting their six-month internships. Fifty-seven new students (class of 2004) were admitted and have begun an intensive summer session. The class of 2004 has an average of 5.5 years of work experience, representing the highest average since the program's inception.

Don Rosenfield continues to serve as the director of LFM Fellows. Codirectors for the program include Paul Lagace, Bill Hanson, and Steve Eppinger.

Research and Knowledge Transfer Program

As part of LFM and SDM's commitment to lifelong learning, an initiative begun last year was continued to encourage LFM and SDM alumni to stay connected with MIT by sharing relevant information. Paul Gallagher, research associate for LFM and SDM, scheduled monthly webcasts presented by MIT faculty and various LFM and SDM alumni. The content of each webcast, also called e-seminars, provides valuable information on the latest trends, cutting-edge developments, and innovative strategies, all of which pertain to manufacturing and/or systems design. The presentations are given in real time, via the internet and telephone, which allowed participants to follow along visually and audibly, as well as to ask questions.

Presenters have included Dan Whitney, describing a theory for designing mechanical assemblies to meet top-level customer requirements on key dimensions; Steve Eppinger on product development interaction patterns; and Steve Graves on supply chain modeling and optimization.

Due to the positive feedback, the webcasts will continue into the next academic semesters.

Outreach

LFM continues its leadership role in the National Coalition of Manufacturing Leadership (NCML), a partnership of 15 universities with joint management and engineering manufacturing programs. In conjunction with the NCML, MIT, the University of Michigan, and Penn State University once again sponsored a recruiting forum, the National Manufacturing Recruiting Forum (NMRF), which was hosted this past year by the University of Michigan. More than 300 students and 20 companies participated in last year's event, in which LFM makes a significant contribution to the NMRF by providing a robust, web-based interview scheduling system that increases interview scheduling efficiency. The number of companies dropped from the previous year's record high of 50 because of the economic downturn. The NCML meets twice a year to share curriculum, research, and program best practices.

Placement

LFM students, sponsored and non-sponsored, continue to be highly sought once they have completed the program. Partner companies as well as other organizations take a special interest in LFM students as proven by their commitment to speak to the class on various issues during the Pro Seminar session. About 80 percent of each class accepts positions within the manufacturing industry while the percentage of students accepting positions within partner companies has remained at about 50 percent.

William C. Hanson
Co-Director

More information about the Leaders for Manufacturing Program can be found on the web at http://lfm.mit.edu/.

System Design and Management

The mission of the System Design and Management (SDM) program is to educate future technical leaders in architecture, engineering, and designing complex products and systems, preparing them for careers as the technically grounded senior managers of their enterprises. SDM intends to set the standards for delivering career-compatible professional education using advanced information and communication technologies. SDM was one of MIT's early entries into the field of distance education and remains the only degree-granting program at MIT that can be earned primarily from a remote location.

The SDM program is a joint offering of the School of Engineering and the Sloan School of Management, leading to a master of science degree in engineering and management. Targeted for professional engineers with three or more years of experience, the program centers on a 13-course curriculum in systems, engineering, and management, including a project-based thesis. It offers three curricular options: a 13-month in-residence format; a 24-month distance education for company-sponsored students, requiring one academic semester in-residence at MIT; and a 24-month on-campus program for self-supporting students who can obtain a research assistantship in one of MIT's labs or centers.

The program was conceived as an alternative to the MBA for professional engineers, allowing working professionals to pursue a degree without interrupting their careers and relocating themselves and their families.

Denny Mahoney, director of the SDM Fellows Program, completed his third year in that position, providing a much-needed stability to program leadership. Co-directors for the program include Paul Lagace, Bill Hanson, and Steve Eppinger.

Student Statistics

In January 2002, SDM admitted its fifth class, enrolling 27 students—a drop from previous enrollments. A team led by Professor Paul Lagace, Denny Mahoney, and Jon Griffith, director of partner relations for LFM-SDM, has been engaged for the past few months in an admissions effort for the January 2003 cohort. Final statistics won't be available until the application deadline closes, but numbers of applications have increased significantly with this effort.

For the first time, SDM put on an informational evening for local MIT alumni and others interested in SDM. This successful event brought in more than 30 prospective students.

Admissions Statistics

	1998	1999	2000	2001	2002
Admitted	58	47	50	37	27
On-campus	16	6	14	8	7
Self-supported	1	2	5	2	1
Research assistant	12	2	4	3	1
Distance education	42	41	36	29	18
Company-sponsored	45	43	41	32	25

System Integration Project

This past year, LFM-SDM and UTC embarked on a new educational venture. UTC has identified 11 core capabilities that the corporation believes must be strengthened across all the business units for UTC to remain competitive in the next century. For each capability, UTC will partner with a university that can deliver the highest quality education to its work force in each of these areas. UTC proposed that LFM-SDM serve as its partner for one of these competencies—systems engineering. UTC believes that much of the current SDM curriculum addresses many of the required capabilities needed for systems engineering that they have identified as important across the UTC business units.

The project team has segmented the educational process into three target populations—a group of experts enrolled in the SDM program, a second group of experts enrolled in UTC-MIT's systems engineering certificate program, and the managers/facilitators of those experts. The pilot year was very successful, with 11 students completing the certificating program and more than 35 managers/supervisors completing the six days of content in the manager/supervisor workshop. Because of the success of the program, the effort has been extended another year. The next cohort of certificate students for this year is at 18.

Distance Education Delivery

As MIT's premier degree program offered at a distance, SDM has recognized its leadership role at the Institute regarding the practice of distance education and is in a process of evaluating its delivery with the goal of increasing the quality of the remote learning experience while reducing costs.

Specific distance education accomplishments include:

- SDM's continuation to deliver the full range of SDM course offerings to all of its students.
- The adaptation of other courses for the distance education medium of multi-point videoconferencing to as many as 15 simultaneous company sites.
- Jan Klein's funding by NASA and Ford Motor Company on a project to apply her research on virtual teams to improving the SDM distance learning experience; she conducted a survey and will introduce and measure specific change elements into the program.

SDM facilitated the purchase of a new videoconference bridge for MIT, which is now housed with the Academic Media Production Services. This purchase has moved a critical component of the distance education program—videobridging of classes—from an outside vendor to inside MIT at a substantial savings to our corporate sponsors. The advantages of the MIT videobridge include being a single supplier for educational support (beyond network access) at MIT, a greater than 50 percent reduction in the videoconferencing related costs of distance learning and the flexibility of providing additional distance learning opportunities.

SDM will continue to explore effective ways of making course materials available to distance students.

William C. Hanson,
Co-Director

More information about the System Design and Management Program can be found on the web at http://sdm.mit.edu/.

Center for Technology, Policy, and Industrial Development

MIT faculty and researchers at the Center for Technology, Policy, and Industrial Development (CTPID) work collaboratively with over 65 sponsoring corporations and government agencies to develop new knowledge and technological strategies that support global economic growth and advance policies that preserve the environment and benefit society at large.

CTPID's ten interdisciplinary research programs focus on contemporary industrial problems that span social, natural, and technological interests. Established in 1985, CTPID hosts programs that address industrial issues in the aerospace, automotive, materials systems, mobility, telecommunications, environmental policy, and technology and law sectors. The programs generated nearly $8 million in research funding in FY2002.

Over 50 faculty and researchers at MIT's Schools of Engineering, Management, and Humanities, Arts, and Social Sciences are affiliated with the center, and 100 more scholars at MIT and other prestigious universities participate in research projects. Faculty and CTPID researchers lead these programs: Cooperative Mobility Program (CMP); Ford-MIT Alliance (administered by CTPID); International Motor Vehicle Program (IMVP); Labor Aerospace Research Agenda (LARA); Lean Aerospace Initiative (LAI); Lean Sustainment Initiative (LSI); Materials Systems Laboratory (MSL); Program on Internet and Telecom Convergence (ITC, formerly RPCP); Program in Science, Technology, and Environmental Policy (P-STEP) co-sponsored with LFEE, and Technology and Law Program (T&L).

Center Accomplishments

CTPID works cooperatively with the Industrial Liaison Program to bring world leaders in industry to MIT through the Industry Leaders in Technology and Management Lecture series. This year speakers included Michael Eskew, chairman and CEO of United Parcel Service, who described his company's transformation from a package delivery service to a global information technology company. Vance Coffman, chairman and CEO of Lockheed Martin, the world's largest defense, Department of Energy, and NASA contractor, described his concept of "Total Awareness: the Real Revolution in Military Affairs." Both talks are available on MITWorld at http://web.mit.edu/mitworld/.

CTPID is one of five selected early adopters of MIT's innovative digital archive, DSpace. The communications office has worked with CTPID programs to populate DSpace, troubleshoot development issues, and has provided an intellectual rights template for use by all faculty, which requests permission for published papers to be posted in DSpace and the author's own MIT web site. This innovation supports the DSpace goal of helping faculty retain and regain rights to their intellectual work.

A series of CTPID community lunches, which build interaction among programs, began in September with a DSpace presentation by faculty liaison Margret Branchofsky. Program presenters included Materials System Lab director Richard Roth, who discussed vehicle light weighting and alternative propulsion systems. Labor Aerospace Research Agenda codirector Joel Cutcher-Gershenfeld presented work on a presidential commission white paper on prospects for the 21st century aerospace workforce. Technology and Law program director Nicholas Ashford discussed "Pathways to Sustainability: Evolution or Revolution?" CTPID director Fred Moavenzadeh described his new work in the Technology and Development program on developing the Malaysia University of Science and Technology.

Program Highlights

The Cooperative Mobility Program, together with other MIT researchers and consultant Charles River Associates, developed a major new study of worldwide mobility trends commissioned by the World Business Council for Sustainable Development. *Mobility 2001* findings include seven grand challenges: ensure transportation systems support economic development and quality of life; adapt the personal-use motor vehicle to future needs; reinvent public transit; reinvent mobility infrastructure management; dramatically reduce carbon emissions; resolve competition between personal and freight transportation; and anticipate and resolve congestion in inter-city transportation.

CTPID, as a partner in the Institute-wide initiative, supports over a dozen projects and twenty researchers working on Ford-MIT Alliance projects. Negotiations are underway for a renewal of this strategic alliance. This year CTPID senior research scientist Daniel Whitney was appointed project area co-manager for the Ford-MIT Alliance focus on product development process technology. Whitney leads the Ford-MIT Assembly Advisor project in this area. Whitney is currently completing a book for Oxford University Press based on his teaching and research in the Ford-MIT Alliance, CTPID's Fast and Flexible program, and LFM-SDM. The Ford/MIT Nobel Laureate lecture series presented talks by Dr. David Baltimore, Nobel Prize winner in physiology or medicine, on "Building a Community on Trust," and John Hume, recipient of the 1998 Peace Prize, on "The Philosophy of Conflict Resolution." They are available online at http://web.mit.edu/nobel-lectures/.

The International Motor Vehicle Program welcomed returning sponsors to the 22-year-old program including Toyota Motor Corporation, Honda Motor Car Company, and General Motors Corporation. A new sponsor, the South Africa Department of Trade and Industry, also joined the program. Researchers from the 20 current IMVP projects shared new work with scholars and industry representatives from the UK, Europe, Japan, Brazil, South Africa, and the US in September. Matthias Holweg, who holds a PhD from Wales's Cardiff University, began a one-year Alfred P. Sloan Industry Centers fellowship with IMVP in May. Holweg is working on build-to-order research.

At the invitation of the Human Capital/Workforce Task Force, US Commission on the Future of the Aerospace Industry, Labor Aerospace Research Agenda researchers produced a policy white paper titled "Developing a 21st Century Aerospace Workforce." LARA also published a guide, *Collective Bargaining in the Face of Instability: A Resource for Workers and Employers in the US Aerospace Industry* and five case studies this year.

Deborah S. Nightingale, professor of the practice in the Department of Aeronautics and Astronautics, was appointed codirector of Lean Aerospace Initiative in February. In LAI's new phase, she will focus on an enterprise approach—working with corporations and associated suppliers to improve the design, fabrication, and delivery process of products. In June, LAI offered its first executive short course based on the program's new book coauthored by Earll Murman, Nightingale, and the LAI team, *Lean Enterprise Value: Insights from MIT's Lean Aerospace Initiative*.

Two aerospace industry leaders—the Boeing Company and Chromalloy Gas Turbine Corporation—joined the Air Force-MIT Lean Sustainment Initiative this year. LSI completed three studies and LAI Director Wesley L. Harris gave invited presentations at the Society of Automotive Engineers Aerospace Congress and Exhibition and the Caribbean Academy of Sciences Conference.

The Materials Systems Laboratory won two National Science Foundation grants in 2001–2002. The grants will support work next year on a study of the application of environmental life cycle analysis to the automotive industry and a study of resource use implications of emerging materials.

Research Program on Communications Policy and its primary program, the Internet and Telecoms Convergence Consortium, merged this year into the MIT Program on Internet and Telecoms Convergence (ITC). ITC's newest member companies include Fundacion Retevision, Marconi, Ellacoya Networks, and Zephyr Telecommunications. ITC director David D. Clark addressed the 2002 MIT Research Directors Conference on "Securing the Future of the Internet," a prime focus of ITC's investigations in media regulation, spectrum allocation, and parameters of broadband competition.

CTPID and the Laboratory for Energy and the Environment launched a new initiative this year, the Program on Science, Technology, and Environmental Policy. The program aims to develop critical knowledge to aid private and government decision-makers, to understand regulatory impacts on industry, to propose alternative regulatory approaches, and to educate leaders to shape the future of environmental protection. A November workshop, "Environmental Risk Management for the 21st Century," gathered industry and government input on how MIT can contribute to improving environmental regulation and performance through research, education, and outreach.

Technology and Law program director Nicholas Ashford organized the Technology and Culture Forum symposium on exploring the many dimensions of sustainable development. Five weekly sessions presented distinguished American and European scholars' comments on growth/economy, environment, and employment as they are affected by technological innovation, globalization, and trade.

CTPID continues to play a key role in the Engineering Systems Division's development by helping to define the division's research agenda and contributing to its development. Both CTPID's research programs and 27-year-old graduate program, Technology and Policy Program (TPP), are now part of ESD.

The second annual TPP conference, titled the Sustainable Mobility Symposium, examined worldwide mobility conditions and challenges May 3. The symposium highlighted the *Mobility 2001* report, commissioned last spring by the World Business Council for Sustainable Development.

Richard de Neufville, TPP founding director and professor of engineering systems, launched a new Cambridge-MIT Institute course. "Real Options for Engineering Systems" was jointly taught with Stefan Scholtes of Cambridge's Judge Institute of Management. Based on ESD.71 and developed with Materials Systems Lab researcher and TPP associate director for education Frank Field III, the course focuses on how to evaluate flexibility in the design of technological developments such as air transport, communication networks, manufacturing facilities, oil fields, power grids, and more.

In another Cambridge University connection, Field MSL researcher Joel P. Clark and Cambridge professor M. F. Ashby coauthored "Market Drivers for Materials and Process Development in the 21st Century," which was published in September in the 25th anniversary issue of the Materials Research Society's *MRS Bulletin*. Find the article online at http://www.mrs.org/publications/bulletin/21stcen/.

The master's technology and policy program and the doctoral technology, management, and policy program enrolled 127 students in 2001–2002. Approximately 35 percent of the students are pursuing dual degrees. This year, 36 students graduated with master's degrees in technology and policy and eight master's students were accepted to continue their studies at the doctoral level. Six doctoral students graduated in 2001-2002.

New Books

Clark, David D., board chair and study member, Computer Science and Telecommunications Board, National Research Council. *Broadband: Bringing Home the Bits*. National Academy Press 2002.

Compaine, Ben, editor. *The Digital Divide: Facing a Crisis or Creating a Myth?* MIT Press, 2001.

McKnight, Lee W., William Lehr, and David D. Clark, editors. *Internet Telephony*. MIT Press, 2001.

Moavenzadeh, Fred, Keisuke Hanaki, Peter Baccini, editors. *Future Cities: Dynamics and Sustainability*. Kluwer Academic Publishers, 2002.

Murman, Earll, *et al. Lean Enterprise Value: Insights from MIT's Lean Aerospace Initiative*, Palgrave, 2002.

Web Innovations

The web site for the MIT Program on Internet and Telecoms Convergence has been redesigned and expanded to include industry and technology headlines. The site links to slides from weekly research seminars, student papers, and research publications. Visit the ITC site at http://itc.mit.edu/.

A newly designed web site for the Labor Aerospace Research Agenda offers research and presentations developed since its founding in 1998. A new compilation of global industry employment data, case studies, and "Developing the 21st Century Aerospace Workforce: a Preliminary Draft of Briefing Materials for US Commission on the Future of the Aerospace Industry" are available. Visit http://web.mit.edu/ctpid/lara/ for more information.

The new International Motor Vehicle Program web site features an online archive of IMVP papers dating from 1990 to 2001, research news, and a password protected area for current research and presentations. Visit IMVP at http://imvp.mit.edu/.

The Cooperative Mobility Program's web site has been expanded from a program description to an active site featuring program news, publications, sponsors, and activities. Visit http://esd.mit.edu/ctpid/cmp/cmp-home.htm.

Honors

Lean Aerospace Initiative co-director Earll Murman, professor of aeronautics and astronautics, won a 2001 Royal Aeronautical Society written paper prize for an article coauthored with Myles Walton and Eric Rebentisch, "Challenges In the Better, Faster, Cheaper Era of Aeronautical Design, Engineering, and Manufacturing" published in the October 2000 issue of *The Aeronautical Journal*.

ITC's Ben Compaine won the AEJMC Robert Picard Award for best new book in media economics for his work titled *Who Owns the Media? Competition and Concentration in the Mass Media Industry*.

ITC director David Clark was elected to the American Academy of Arts and Sciences.

Family and colleagues of MIT Professor Wesley L. Harris established the Wesley L. Harris scholarship fund for MITE^{2}S (Minority Introduction to Engineering, Entrepreneurship and Science), a summer program at MIT for underrepresented minority high school students.

Joseph M. Sussman, J R East professor of civil and environmental engineering and CMP researcher, won the 2001 Roy W. Crum Award from the Transportation

Research Board for his contributions to research on railroads, intelligent transportation systems, and other large, integrated systems.

Daniel Whitney, CTPID senior research scientist, received a School of Engineering Infinite Mile award for institutional bridging at the second annual School of Engineering awards ceremony April 11.

T&L Director Nicholas Ashford, a fellow of the American Association for the Advancement of Science, has been elected chair-elect of the group's section on the Societal Impacts of Science and Technology.

Chris Magee, the Ford-MIT Alliance executive director for 2000–2001, was appointed professor of the practice of mechanical engineering and engineering systems. Magee received the William Hunt Eisenman Award from ASM International, the Materials Information Society for "innovative leadership in integrating advanced materials technologies, implementing system engineering perspectives, and applying computer-aided engineering tools to the development of worldwide automotive products."

CTPID director Fred Moavenzadeh, the James Mason Crafts professor of systems engineering, received the deFleury Medal for his service to the US Army Corps of Engineers. Professor Moavenzadeh has mentored more than 50 graduate students who went on to become Army engineers. He is developing a course on engineering leadership, in collaboration with the Army's ROTC program, the Sloan School of Management, and the Corps's New England district. He is also collaborating with the Federal Emergency Management Agency and USACE to explore an "engineers without borders" concept, a privately supported international relief organization.

Personnel

Professor Deborah Nightingale, from the Department of Aeronautics and Astronautics, succeeded department colleague Professor Earll Murman as LAI codirector in January. LARA codirector Joel Cutcher-Gershenfeld has been named executive director of the Engineering Systems Learning Center, which is producing cases, simulators, and other educational materials on complex systems. Betty Jo Barrett, a postdoctoral fellow since 1999, is now LARA's project research manager. TPP Director Dan Hastings is now associate director of the Engineering Systems Division. Patty Proven joined the CTPID communications staff as assistant to CTPID, IMVP, and TDP.

Visiting Scholars

CTPID visiting scholar Carlos Rodriguez Casal, associate professor of electrical/electronic engineering at the Universidad Publica de Navarra in Spain, worked with ITC on legal and institutional issues regarding location services for wireless communication through February. Ki-Chan Kim, director of the Institute of Industry Management and associate professor of management at the Catholic University of Korea, continued his work on automotive supply chains with IMVP. Sanyho Park, assistant professor of Mechanical Design Engineering at Korea's Chungnam National University, worked with Dan Whitney on research in computer-assisted design.

Future Plans

As part of a larger ESD counter-terrorism initiative, CTPID director Fred Moavenzadeh and John Williams, associate professor of civil and environmental engineering and engineering systems, began collaborating this spring with Sandia National Laboratories colleagues on technology issues related to national security. The ESD-Sandia team are planning a meeting at Sandia in August and a comprehensive workshop in fall 2002 to identify key research topics in this field.

LSI is developing support to found a LSI Institute in conjunction with the US Air Force and an industry consortium. The LSI Institute would focus on developing global partnerships to improve the effectiveness and efficiency of MRO delivery and to train and educated MRO leaders.

Fred Moavenzadeh
Director
James Mason Crafts Professor of Engineering Systems

More information about CTPID can be found on the web at http://web.mit.edu/ctpid/www/.

CTPID Program Reports

Cooperative Mobility Program

The Cooperative Mobility Program (CMP) brings together transportation scholars from MIT and other universities with private sector specialists and corporate sponsors to explore current and future issues of worldwide mobility. CMP proposes a new vision: a sustainable multi-modal transportation system that will provide the mobility necessary to foster global economic development compatible with social needs and environmental concerns.

CMP is grounded in empirical research on travel behavior, technological approaches, and public policies that affect mobility in both developed and developing countries. CMP compiles an annual mobility observatory that tracks innovative developments in transportation policy, management, and technology.

Program research served as the basis for a large-scale global study of passenger and freight mobility and a May 2002 Sustainable Mobility Symposium, the Technology and Policy Program's second annual conference. The symposium highlighted *Mobility 2001*, a report

commissioned by the World Business Council for Sustainable Development as a first step toward developing a vision of more sustainable mobility in the future. *Mobility 2001*, prepared by researchers from CMP and other MIT programs and by Charles River Associates, is the most comprehensive and large-scale global initiative in sustainable transport.

More information about CMP, which is directed by Daniel Roos, associate dean for engineering systems, can be found on the web at http://esd.mit.edu/ctpid/cmp/cmp-home.htm/.

Ford-MIT Alliance

In an innovative program, the Ford Motor Company has engaged the Institute in addressing an array of 21st-century challenges confronting the automotive manufacturer. The initial multimillion-dollar, five-year alliance began in 1997 with a focus on three research areas: product development process technology, virtual education, and the environment. Priorities include the study of engineering design and educational environments of the future and funding to support a major MIT-directed consortium to study and address global environmental challenges. An objective of the alliance is the development of effective mechanisms for longterm, corporate/university partnerships. MIT and the Ford Motor Company are currently negotiating a renewal of the alliance.

CTPID administers the overall grant and is home to several of the Ford-MIT Alliance projects. As part of Ford's engineering research, CTPID senior research scientist Daniel Whitney is leading a project on Assembly Advisor, incorporating assembly information in computer-aided design systems. He is also involved, with Professor Steven Eppinger, in a project called Information-Based Product Development that explores appropriate information technology tools for synthesizing complex information in product development programs. Janice Klein, senior lecturer at the Sloan School of Management, heads research on virtual teams. George Roth, executive director of the Ford-MIT Alliance program and research associate in the Sloan School of Management, also leads a research effort on the organizational changes implied by MIT's alliances with corporations.

Chris Magee, who served as Ford's executive director of the alliance in 2000–2001, worked to strengthen the linkage between MIT and Ford and develop new collaborative research areas. This year he joined the MIT faculty as professor of the practice of mechanical engineering and engineering systems and now heads the Center for Innovation in Product Development.

As a partner in this Institute-wide initiative, CTPID supports over a dozen projects and twenty researchers working on Ford-MIT projects. MIT faculty involved in the Ford-MIT Alliance use conferences, videoconferences, web sites, and virtual forums to communicate the results of this work to both Ford and the general public. George Roth services as executive director of the alliance. More information about the Ford-MIT Alliance can be found on the web at http://ford-mit.mit.edu/.

International Motor Vehicle Program

IMVP, the largest international research group studying and reporting on the automobile industry and its global milieu, this year has built sponsor support for Phase IV, titled Navigating Auto's Next Economy (NextAuto), launched in September 2000. Toyota Motor Corporation, Honda Motor Car Company, General Motors Corporation, and the South Africa Department of Trade and Industry have signed sponsorship agreements. A newly designed web site presents IMVP news for the public and new research papers and materials for sponsors.

Matthias Holweg won a one-year Alfred P. Sloan Industry Centers Fellowship to conduct build-to-order research at IMVP program headquarters at CTPID. Holweg, who arrived in May, recently earned his PhD from Wales's Cardiff University. He has worked with IMVP, Cardiff's Lean Enterprise Research Centre, and the International Car Distribution Program's joint 3DayCar Program. Holweg coauthored "Successful Build-to-Order Strategies Start with the Customer" in the fall 2001 *Sloan Management Review*. Susan Helper, IMVP principal investigator for research on e-commerce among second-tier suppliers, has been promoted from associate professor to professor in the Department of Economics at Case Western Reserve University.

IMVP's NextAuto Phase provides industry-wide knowledge and insight essential to helping companies make strategic decisions. Since 1980, IMVP has provided an unbiased, detailed, and integrated view of the dynamics of the worldwide automotive industry and its important drivers. IMVP and its predecessor, the Future of the Automobile program, have received funding from the Sloan Foundation, automakers worldwide, and their suppliers since the late '70s.

NextAuto reflects sponsor feedback urging IMVP to draw upon its historic strengths to examine the industry's next challenges. Through NextAuto, IMVP researchers and their industry partners will integrate research capabilities on the extended enterprise with the new opportunities afforded by e-business and catalyzed by environmental and sustainability issues. NextAuto research priorities include over twenty projects underway in 2001–2002 in the following research areas: managing the extended enterprise; benchmarking the value chain; modularity and outsourcing; R&D; product development strategies; building skills and capabilities across boundaries; e-automotive; e-supply chains and hubs; e-powered consumers/build-to-order;

telematics; vehicle as IT/telecom platform; visions for a sustainable future; green drive trains; new materials, recycling, and environmental management; and mobility solutions.

Associate professor John Paul MacDuffie at University of Pennsylvania's Wharton School is IMVP codirector and Professor Fred Moavenzadeh is acting codirector. Donna Carty is program manager. More information about IMVP can be found on the web at http://imvp.mit.edu/.

Labor Aerospace Research Agenda

The Labor Aerospace Research Agenda (LARA) began in June 1998 with the belief that people are at the heart of new work systems—establishing stability and then driving continuous improvement. LARA was designed to further the understanding of this critical social dimension of lean principles in the aerospace industry.

In its early phases, LARA administered a national aerospace survey to further the understanding of the impact of instability on employment and work practices in the aerospace industry. Working with the Lean Aerospace Initiative, several case studies and other reports have been developed to increase the understanding at the facility and individual levels. These include the following:

- Case study: a decade of learning; International Association of Machinists and Boeing Joint Programs
- Case study: transformation through employee involvement and workplace training: The challenge of a changing business context; Rocketdyne Propulsion and Power and the United Automobile Workers
- Case study: employing activity-based costing and management practices within the aerospace industry: sustaining the drive for Lean. Boeing Commercial Airplane Group, Wichita Division, and the International Association of Machinists
- Case study: fostering workplace innovation and labor/management partnership: the challenge of strategic shifts in business operations; Pratt and Whitney (UTC) and the International Association of Machinists
- Case study: fostering continuous improvement in a changing business context; Textron Systems
- Case study: from three to one: integrating a high performance work organization process, lean production, and activity-based costing change initiatives; Boeing Commercial Airplane Group, Wichita Division, and the International Association of Machinists

In 2001–2002, LARA also produced a white paper entitled "Developing a 21st Century Aerospace Workforce," which was created at the invitation of the Human Capital/Workforce Task Force, US Commission on the Future of the Aerospace Industry. The LARA team is continuing to work with this commission as recommendations are being developed on intellectual capital and global employment issues in the aerospace industry. LARA also published a guide, *Collective Bargaining in the Face of Instability: A Resource for Workers and Employers in the US Aerospace Industry.*

LARA is an MIT-based team conducting research with funding provided via the manufacturing technology initiative of the US Air Force and other sources. LARA's coprincipal investigators/codirectors are senior research scientist Joel Cutcher-Gershenfeld and Professor Thomas A. Kochan. More information about LARA can be found on the web at http://web.mit.edu/ctpid/lara/.

Lean Aerospace Initiative

The Lean Aerospace Initiative (LAI) is an evolving learning community that brings together key stakeholders from 25 aerospace companies, 15 US government offices and programs, organized labor, and MIT. LAI is a consortium-guided research program led by the MIT Department of Aeronautics and Astronautics in close collaboration with the Sloan School of Management, and managed under the auspices of the Center for Technology, Policy, and Industrial Development. LAI also collaborates internationally with the Lean Aerospace Research Program at Linköping University and the UK LAI.

The Lean Aerospace Initiative was born out of practicality and necessity as declining defense procurement budgets collided with rising costs and military industrial overcapacity prompting a new defense acquisition imperative: affordability rather than performance at any cost. The initiative was formally launched in 1993 when leaders from the US Air Force, the Massachusetts Institute of Technology, labor unions, and defense aerospace businesses forged a partnership to transform the industry, reinvigorate the workplace, and reinvest in America using a philosophy called lean.

Lean is about people and processes efficiently delivering value to every stakeholder. This means achieving lean capability at the enterprise level. Creating lean enterprise value goes well beyond figuring out better ways to do the job right—it's also about doing the right job. It means eliminating waste with the goal of creating value, being responsive to change, continually focusing on quality, and enhancing the effectiveness of the entire workforce.

Today, LAI's community extends forward to the customer and reaches back through the supply chain. The consortium now consists of leaders and implementers from major US defense and commercial aerospace companies, suppliers, government agencies, organized labor, and MIT.

Through active partner collaboration, LAI functions as a real-world laboratory. Resulting benchmarking data and

other findings fuel an ongoing cycle of learning including the application of knowledge, assessment of progress, and continuous improvement. Ultimately this cycle generates new research questions leading to new results and lasting value. It also provides a foundation for more tangible and meaningful tools and products that enable lean transformation efforts across the enterprise—products such as the Lean Enterprise Model, the Enterprise Transition To Lean Guide, and the Lean Enterprise Self-Assessment Tool. LAI's research base also continues to fold into policy recommendations.

Accomplishments, Research Results, and Knowledge Products

Through its ongoing Lean Effects on Aerospace Programs exploratory study, LAI has found strong impact from lean occurring from 1992 to 2000, with a large acceleration since 1997 representing as much as ~60 percent increase in inventory turns; 40+ percent increase in labor productivity (current $); and as much as 80 percent reduction in product development cycle time. This research also revealed that lean remained heavily concentrated on the factory floor. Basic lean changes still, however, benefit as much as 95 percent of shipped products and affects 40 percent to 80 percent of all manufacturing and procurement processes.

Other recently published research includes findings and recommendations in these areas: the internet as an enabler to the Lean enterprise; framework for comparing performance improvement programs; value creation in the product development process; fostering innovation across aerospace supplier networks; Lean thinking in aircraft flight testing; valuation techniques for commercial aircraft design; manufacturing system design in the defense aerospace industry; flexible manufacturing systems and value stream mapping; and valuation techniques for complex systems.

As of May 2002, the LAI student roster totaled 16 MS and PhD candidates: eight in Aeronautics and Astronautics; four in Technology and Policy; two in Technology, Management and Policy; and one each in Mechanical Engineering, the Sloan School, and a USAF research fellow.

Also as of May 2002, 57 MS and PhD graduates entered these fields: 12, government service; 10, aerospace industry; 15, consulting industry; 18, other professions; two, continuing studies at MIT.

Lean Transformation Tools and Products

In the past year, LAI has stepped up efforts to help transform the US aerospace enterprise by developing and deploying education programs as well as leadership and transformational tools including:

Transition-to-Lean Roadmaps—Supplier Networks and Product Development Alpha versions were released.

Lean Enterprise Self-Assessment Tool (LESAT) Version 1.0 delivered August 2001, public unveiling in November 2001. Developed in collaboration with the UK LAI, LESAT enables the leadership of an enterprise to assess the "leanness" of the enterprise as well as its readiness to transform itself in accordance with Lean principles and practices. The tool was field-tested over an 18-month period at AIRBUS (UK), BAE Systems, Boeing Helicopters, Dowty Propellers, FR HiTemp, GenCorp Aerojet, Hurel Dubois (UK), Lockheed Martin Aeronautics, Lockheed Martin Space Systems, Matra BAe Dynamics, Northrop Grumman, Pratt & Whitney, Raytheon, Rockwell Collins, Rolls Royce, Sikorsky Helicopters, Smiths Industries Aerospace, Textron Systems, and TRW Aeronautical Systems.

Lean Learning II Workshop—The race toward lean knowledge accelerated when 74 learners, change agents, and implementers from across the aerospace community, gathered for LAI's Lean Learning II workshop in Charlotte, North Carolina, November 6–8, 2001. The second in a series of activity-based professional development forums, this workshop emphasized both people and process, and focused on the organizational behaviors as well as specific tools, such as LAI's LESAT, that enable lean transformation. It also featured an emerging LAI product *The Workbook for Change*, a how-to soft skills guide.

Lean Enterprise Value: Insights from MIT's Lean Aerospace Initiative (LEV), published by Palgrave in March 2002, outlines the core challenge for industry in the 21st century as the ability to identify and deliver value to every stakeholder and the subsequent requirement of lean capability at the enterprise level. LEV demystifies the three levels of enterprise, offers a value creation framework, and concludes with enterprise level Lean principles.

Enterprise Value: The New Lean Horizon, the annual stakeholders conference held March 26-27, 2002, featured key lessons from *Lean Enterprise Value* and honed in on the larger concepts of what an enterprise is by looking beyond manufacturing successes to the greater opportunities associated with addressing an enterprise as a whole.

Speakers included Bob Nelson, corporate vice president for business strategy, Northrop Grumman Corporation; Carolyn Corvi, vice president/general manager of Boeing's 737 program; Mike Fortson, director of JSF affordability, Lockheed Martin Aeronautics; and Ellen Plese, Atlas Program Office, Lockheed Martin Astronautics.

"Our experience with Lean principles has shown that Lean enables the cultural, process, and systems integration required to meet future customer requirements," said Bob Nelson. "Lean also offers a new common denominator."

The LAI-Defense Acquisition University (DAU) Strategic Partnership was established on May 22, 2002. LAI and

DAU signed a memorandum of understanding to engage in collaborative work in two broad areas: acquisition research and curriculum development. Work started on development of a web based introductory learning module of basic lean concepts suitable for government, industry, or academic applications. Future work may include collaboration on the inclusion of lean enterprise perspectives in the DAU capstone program manager's course.

On June 19–21, 2002, Lean Aerospace Initiative presented its first Lean Enterprise Value executive short course to 25 leaders and implementers from aerospace. Designed and built around an integrated enterprise simulation game, this class encouraged experiential learning and immediate application of lecture materials. Content was derived from the LEV book beginning with an overview of lean fundamentals and culminating with a broad perspective of the integrated operations between the enterprise functions and their impact on achieving a lean enterprise transformation.

Moving Forward

LAI has taken flourished as a new model of industry, government, labor, and university partnership. But perhaps more importantly, LAI represents a true learning community with the ability to leverage multiple perspectives for longer-term solutions. Through this community, LAI is able to open and sustain knowledge sharing, create a common vocabulary, infuse new ideas into the industry, and enhance communication among all stakeholders. This accelerates lean transformation efforts by bridging sectors and cultures as well as organizational functions, layers, and competing interests. It also creates a system to rapidly diffuse best practices throughout the enterprise. Now LAI is poised to do for the rest of the enterprise what it did for manufacturing.

As LAI begins its next phase, the enterprise value phase, in September 2002, the consortium will work to shift mindsets away from silos and into the enterprise, and to broaden LAI impact up, down, and across value streams.

LAI itself will model best practices by focusing on integrated goals, deliverables, and products that meet the needs of multiple stakeholders. As part of this vision, LAI is introducing the LAI Educational Network, a cadre of colleges and universities who can help to foster lean thinking through education while expanding curriculum development and delivery.

LAI Leadership

Effective Monday, January 28, 2002, Professor Deborah Nightingale, of the Department of Aeronautics and Astronautics, succeeded department colleague Professor Earll Murman, as LAI co-director. Nightingale shares leadership responsibilities with Professor Tom Allen, MIT Sloan School of Management, and a third codirector from an industry to be determined, a role most recently held by former Boeing executive Fred Stahl. More information about the Lean Aerospace Initiative can be found online at http://web.mit.edu/lean/.

Lean Sustainment Initiative

Established in 1997, the Lean Sustainment Initiative (LSI) mission is to enable a fundamental transformation of the US commercial and military maintenance, repair, and overhaul (MRO) industries into cost effective, quality driven, timely, and responsive support enterprises. As a joint academic/military/industry consortium, LSI develops research-based recommendations for systemic change followed by the implementation of military/industry pilot projects to demonstrate the impact of the recommendations on the MRO effectiveness of the enterprises.

Two aerospace industry leaders have joined the Lean Sustainment Initiative, a development that signals firm industry commitment to streamlining the US Air Force's $5.4 billion dollar MRO operations. The Boeing Commercial Airplane Company and the Chromalloy Gas Turbine Corporation joined LSI in late 2001. In joining LSI, these industry leaders reinforce existing efforts to apply lean principles, processes, and practices to the sustainment operations, business processes, and enterprise integration that keep the backbone of America's air defense system—legacy aircraft like B-52s, C-5s, F-15s, F-16s, KC-135s—in the air. Boosting sustainment efficiency could increase the percent of US air war fighters that can go into immediate action within existing fiscal constraints about 75 percent.

During 2001-2002, LSI completed three studies: the impact of policy on the availability of materials and parts; identification of barriers preventing the flow of high quality data input to forecasting tools; and identification and quantification of goals, objectives, and metrics that drive behavior and performance at the flight line. Based on the results of these studies, recommendations for implementation pilots have been developed and presented by MIT for LSI stakeholder review.

LSI delivered invited presentations at the Society of Automotive Engineers Aerospace Congress and Exhibition, September 10–14, 2001, Seattle, Washington, and the Caribbean Academy of Sciences 13th Annual Meeting and Conference, June 1–4, 2002, Mona, Jamaica.

The initiative produced several master's theses, white papers, and technical briefings.

Next year's plans include initiatives to expand the stakeholder base to include international corporations and more national corporations; to continue the development of graduate and executive level sustainment courses with analytical framework and case studies; and to initiate implementation pilots.

Professor Wesley L. Harris is the LSI director. More information about LSI can be found on the web at http://www.leansustainment.org/.

Materials Systems Laboratory

The Materials Systems Laboratory (MSL) is internationally recognized for its innovative work analyzing the competitive position of materials and the strategic implications of material choice. This year the Materials Systems Laboratory won two National Science Foundation grants. The grants will support work next year on a study of the application of environmental life cycle analysis to the automotive industry and a study of resource use implications of emerging materials.

For nearly two decades, MSL has addressed issues arising from materials choice in a range of applications, particularly those in the automotive, electronic, and aerospace industries, but with a recent emphasis on automotive applications. MSL's research sponsors include major automakers and materials suppliers. Recent agreements with General Motors should provide MSL will the basis for doing more in-depth research into various aspects of automotive manufacturing.

MSL's work builds upon a unique combination of materials processing knowledge, engineering design practice, manufacturing process analysis, and environmental information to construct analytical tools for decision support and competitive analysis. To develop these tools, MSL has worked extensively to refine its extensions to classic engineering process modeling for the past two decades. Modeling elements have been married to elements of product design, material properties, and manufacturing assumptions to yield tools that can estimate the costs of product manufacture under a wide range of conditions. These tools analyze primary materials production, primary materials processing, component and subassembly manufacture, and end-of-life vehicle processing. In each case, these tools estimate the costs of production as a function of processing technology, material flows, operating conditions, and energy and capital requirements.

MSL also has developed techniques for understanding how markets respond to the different combinations of engineering and economic performance available by using different materials. Further, MSL researchers analyze the environmental consequences of materials and process choice, incorporating the emerging life cycle analysis paradigm. These tools make it possible, when used with economic and engineering assessments, to develop robust, credible, and defendable product strategies that take life cycle information into account.

Richard Roth is the director of MSL. More information about the Material Systems Laboratory can be found on the web at http://msl1.mit.edu/msl/.

Program on Science, Technology, and Environmental Policy

The new Program on Science, Technology, and Environmental Policy (P-STEP) is an MIT initiative aimed at working with the US Environmental Protection Agency and industry representatives to improve environmental regulation and performance through research, education, and outreach. P-STEP gathered industry representatives and area researchers at MIT in November to discuss core principles through a workshop titled, "Environmental Risk Management for the 21st Century."

Technology and Policy Program master's student Lewis McCulloch, the program's first research associate, helped organize the fall conference and contributed to the P-STEP white paper, currently being circulated to 250 industry leaders. The program, jointly sponsored by the Laboratory for Energy and the Environment and CTPID, aims to promote innovation on three levels: development of improved analytic approaches and methods for risk assessment and regulatory instrument design; development and diffusion of new risk mitigation technologies; and communication methods for informing policy makers about the nature of the environmental risk and cost-effective means for reducing them.

The P-STEP research team includes CTPID director Fred Moavenzadeh, Materials Systems Lab researcher Joel P. Clark, and Frank Field III, CTPID senior research engineer. For more information, contact the codirectors Thomas Eager or Joanne Kauffman. More information about P-STEP can be found on the web at http://p-step.mit.edu/.

Program on Internet and Telecoms Convergence

The Program on Internet and Telecoms Convergence (ITC) is MIT's only sponsored research program focused on furthering the Internet's evolution into a critical, global communications infrastructure. ITC researchers and industry and academic partners investigate the technical, economic, strategic, and policy issues that arise from the convergence of telecommunications and the Internet.

ITC Research shaped industry practice, filtered hype, through reality checks and identification of real R&D needs, provided advance insight into emerging technologies and business practices andinformed policy makers, forestalling premature or ill-conceived regulatory initiatives.

The Program on Internet and Telecoms Convergence receives funding from a select group of large and small enterprises with a strategic interest in the telecommunications and/or internet arena. In 2001–2002 large members were British Telecom, Fundacion Retevision-Auna, Hewlett-Packard, Motorola, Nokia, and Sprint and small members were Ellacoya Networks, Vanu, Inc., and Zephyr Telecom.

ITC Members Meetings

ITC held two members meetings for executive briefings and technology previews.

The two-day January 2002 meeting, held in Cambridge, included the work of ITC director David D. Clark. His topic was "Securing the Future of the Internet." Homeland security interfaced with the ITC in a talk by Robert Pepper, chief of the Office of Plans and Policy, Federal Communications Commission. Among the principal objectives of the homeland security effort are to secure the nation's communications infrastructure and to enhance emergency response through communications. Achieving these objectives involves many of ITC's core interests: media regulation, spectrum allocation, and parameters of broadband competition. ITC executive director Sharon Eisner Gillett presented "Business Models for Bottom-up Wireless Internet."

The June 2002 meeting was hosted by ITC member Fundacion AUNA in Madrid, Spain. The meeting's title was "Divergent Convergence: Competing Visions for the Internet." Topics centered around two themes: broadband and the wireless internet. ITC associate director William Lehr spoke on "Implications of Software Radio for Industry Structure." John Wroclawski, research scientist at the Laboratory for Computer Science and ITC, updated the group on the "Personal Router and the Wireless Internet."

Seminars

ITC held weekly research seminars throughout the year, with presentations by ITC researchers as well as outside guests. Among the presentations:

- Craig Warren Smith, Digital Corporate Citizenship: The Business Response to the Digital Divide
- David Gabel, FCC's Unified Intercarrier Compensation Regime: Bill and Keep
- William Lehr, Interconnection and Access Price Regulation
- Mark Gaynor, The Effect of Market Uncertainty on the Management Structure for Network-based Services
- Peyman Faratin, Multi-Agent Negotiation

Publications and Awards

ITC researchers and affiliates published or presented research results in over 18 venues this year. Highlights were:

Clark, David D., ITC director, board chair and study member, Computer Science and Telecommunications Board, National Research Council. *Broadband: Bringing Home the Bits*, National Academy Press 2002.

Osorio, Carlos A., "A Contribution to the Understanding of Illegal Copying of Software: Empirical and Analytical Evidence Against Conventional Wisdom." Working paper, June 2002. He also won a Best Poster award at the June Internet Society annual conference, INET 2002.

Benjamin Compaine received the 2002 Journal of Media Economics Award of Honor which "recognizes contributions to media economics scholarship and to the development of the discipline during the careers of the recipients."

A completed study on internet appliances generated two papers: Gillett, Sharon, William Lehr, John Wroclawski, and David Clark, "Do Appliances Threaten Internet Innovation?" Also in *IEEE Communications* special issue, October 2001; and Gillett, Sharon, William Lehr, John Wroclawski, and David Clark, "The Disruptive User—Internet Appliances and the Management of Complexity" in *BT Technology Journal*, October 2001.

De Figueiredo, John, "Committee Jurisdiction and Internet Intellectual Property Protection." 2002.

Sirbu, Marvin, Carnegie Mellon University, "Fiber to the Home." Presented to the IEEE Ethernet in the First Mile Standards Body, 2002.

An ITC collaboration with the Sloan School, Political Science Department, and Media Lab, and seed funding from the eBusiness Vision Fund, produced the presentation below and a conference in October 2002: Siegel, Michael, Farnaz Haghseta, and Shawn O'Donnell, "e-Readiness Framework and Tools: Goals and Approach." Presented at the MIT Center for eBusiness Seminar, March 6, 2002.

ITC researchers presented three papers at TPRC 2001, Alexandria, Virginia. McKnight, Lee, Raymond Linsenmayer, and William Lehr, "Best Effort versus Spectrum Markets: Wideband and Wi-Fi versus 3G MVNOs?" Also published in the journal *Info*. O'Donnell, Sean, Hugh Carter Donahue, and Josephine Ferrigno-Stack, "Quality of Service Monitoring: Performance Metrics across Proprietary Content Domains"; and Gillett, Sharon, and Emy Tseng, "Unbundling Fiber to the Home."

Dr. David Clark, senior research scientist at the Laboratory for Computer Science, directs the Program on Internet and Telecoms Convergence. Sharon Eisner Gillett is executive director; William Lehr, associate director. More information about the Program on Internet and Telecoms Convergence can be found on the web at http://itc.mit.edu/

Technology and Law Program

The Technology and Law (T&L) Program offers research opportunities and graduate level courses focusing on the interface of law and technology. Research activities include the design and evaluation of policies that encourage technological change for preventing chemical pollution through regulation, liability, and economic incentives; promote environmental justice by involving communities in governmental decisions that affect their health, safety, and environment; and address the effects of globalization on sustainability.

T&L offers a two-semester sequence in environmental law and policy: Law: Technology, and Public Policy, a core subject in the Technology and Policy Program; and Sustainability, Trade, and Environment, listed jointly with Engineering and Sloan.

Recent Publications

Ashford, N. A., "Justice in the Global Work Life: The Right to Know, to Participate, and to Benefit in Sustainable Industrial Transformations." In Proceedings of the High-level Conference on Work Life in the 21st Century, 15-17 October 2001, Helsinki, in *People and Work Research Reports 49*, the Finnish Institute of Occupational Health, 2002.

Ashford, N. A., "Pathways to Sustainability: Evolution or Revolution?" In *Innovation and Regional Development in the Network Society*, Marina van Geenhuizen, David V. Gibson, and Manuel V. Heitor (eds.), QUORUM Books: Series on "Technology Policy and Innovation," Volume 7. 2002, http://in3.dem.ist.utl.pt/quorumseries/.

Ashford, N. A., "Innovation: the Pathway to Threefold Sustainability" in *The Steilmann Report: The Wealth of People: An Intelligent Economy for the 21st Century* Lehner, Franz, Charles, Anthony, Bieri, Stephan, and Paleocrassas, Yannis (eds.) Brainduct ® - digital edition, 2001 pp. 233-274, based on Ashford, Nicholas A., "Technological, Organizational, and Social Innovation as Pathways to Sustainability."

Ashford, N. A., "Implementing a Precautionary Approach in Decisions Affecting Health, Safety, and the Environment: Risk, Technology Alternatives, and Tradeoff Analysis." In the Role of Precaution in Chemicals Policy, *Favorita Papers* 01/2002, Elisabeth Freytag, Thomas Jakl, Gerhard Loibl, Michael Wittmann (eds.), Diplomatic Academy, Vienna, pp. 128-140.

Ashford, N. A., "Government and Innovation in Europe and North America." In a special issue on ecological modernization, Sonnenfeld, David and Mol, Arthur, (eds.), *American Behavioral Scientist*, vol.45, no. 9, pp. 1417-1434, 2002.

Now available in PDF: "Public Participation in Contaminated Communities" at http://web.mit.edu/ctpid/www/tl/TL-pub-PPCC.html.

More information about the Technology and Law Program can be found on the web at http://web.mit.edu/afs/athena/org/c/ctpid/www/tl/.

Center for Transportation and Logistics

In June, the former Center for Transportation Studies changed its name to the Center for Transportation and Logistics. The change in name reflects the center's efforts to expand its focus on logistics and supply chain management.

Established in 1973 to develop and coordinate the wide range of transportation-related activity at MIT, the center provides a focal point for transportation education, facilitates transportation research, conducts an outreach program to the transportation industry, and encourages a sense of common purpose among the many departments, centers and laboratories involved in transportation and logistics at MIT.

On our web site there is a wealth of information about the center and its programs, including descriptions of current research projects, and a listing of MIT theses in transportation since 1980. Transportation faculty and research staff are also listed with their areas of interest, along with connections to other interesting resources on the web. The URL is http://web.mit.edu/ctl/www/.

Education

Thirty-two new students arrived on campus this fall to enter the center's new Master of Engineering in Logistics program, an intensive nine-month degree track preparing graduates for logistics management careers in manufacturing, distribution, retail, transportation and logistics organizations.

Again this year, because of the high quality of applications, qualifying for graduate admission for transportation studies was increasingly difficult. This year, 170 applications were received for graduate studies in transportation—including the Master of Science in Transportation (MST), the Master of Engineering in Logistics (MLOG) and the PhD programs—and 94 students were enrolled in AY2002. Funding was found for 64 percent of the students.

Research

During the past academic year, over 100 projects were posted on the center's current research listing, organized in thirteen categories and representing the work of more than 50 researchers in more than a dozen departments and research centers. Many of those entries were research programs which included within them still more individual projects.

Major New Projects

MIT embarked upon a project with the Volpe National Transportation Systems Center and the Logistics

Management Institute to assess the effects of alternate technology and policy options on aviation-related emissions. The model they are developing will be able to analyze aircraft, airport, regional and global issues in terms of performance, fuel burn, emissions, traffic and traffic growth.

The center was named as the new seat of the FAA Center for Excellence at MIT focusing on the development and use of operations research to address specific issues in air traffic control; human-in-the-loop systems; system performance and assessment; flow control and scheduling; operations research and simulation tools; governmental and user communications; navigation, communication and data; software certification and reliability; and aviation safety.

Major Meetings and Audio Conferences

On January 10, an affiliates seminar was held at the MIT Faculty Club exploring dynamic pricing techniques and their impact on supply chain management. Speakers included David Simchi-Levi, professor of engineering systems; Peter Belobaba, principal research scientist; Scott Friend, CEO of ProfitLogic; and Blair Pomeroy, global director of airline strategy, Accenture.

On March 19–20, an affiliates seminar was held at the MIT Faculty Club examining the different options available to increase the effectiveness of spare parts inventory. Speakers included Bob Stoffel, senior vice president of service parts logistics, UPS; David Simchi-Levi, professor of engineering systems; Mike Landry, CEO and founder, Servigistics; Larry Newbanks, manager, inventory technology research, Caterpillar Logistics Services, Inc.; Stephen Graves, Abraham J. Siegel professor of management at MIT; and Derrick Redding, MLOG candidate at MIT.

On May 20–21, an affiliates seminar was held at the MIT Faculty Club featuring insights on using service as a competitive weapon. Speakers included MIT lecturer Dr. Jonathan Byrnes; Bill Homa, CIO, Hannaford Brothers; Tom Gormley, MIT Center for Information Systems Research; John S. Stanley, COO and deputy director for operations, Boston Museum of Fine Arts; John Wass, CEO, SwiftRivers; and Rex Williams, general manager, GE Engines Services Inc.

The inaugural luncheon of the Horace B. Deets Lecture Series, Aging: Looking to the Future, was held May 7, 2002. Featured speakers included Horace Deets, retired executive director of the AARP; Thomas Perls, M.D., associate professor of medicine and director, New England Centenarian Study, Boston University Medical School (What Can We Learn from Today's Centenarian for Tomorrow's Older Boomers?); and Richard Weinshilboum, MD, professor of molecular pharmacology, experimental therapeutics and internal medicine, Mayo Medical School and Mayo Clinic (Pharmacogenomics: Inheritance and Drug Response). There were 115 individuals who participated.

The affiliates program in logistics held its first audio conference in September on benchmarking in logistics. In attendance at the MIT end were Ed Schuster, director of the affiliates program; Jim Rice, director of MIT's Integrated Supply Chain Management; Deborah Hoffmann, research director for benchmarking practice at AMR Research, and Larry Lapide, vice president and general manager for benchmarking services at AMR Research. Scattered about the country at about 35 other locations, with as many as four in attendance at each location, were representatives of 15 member companies.

On November 20, the center conducted an audio conference with John Heywood, director of MIT's Sloan Automotive Laboratory, discussing engines and fuels for future transportation systems, including both conventional and new types of internal combustion engines. Twelve corporate members of the center's affiliates program in logistics took part at 19 different ports in the US and abroad.

On November 2, the center conducted an audio conference on global terrorism and its impact on supply chain management. Taking part at the MIT end were lecturer Jonathan Byrnes, Yossi Sheffi, and Barry Pozen, professor of political science.

Smaller Functions

The Distinguished Speaker series featured the following:

- September 28. Mr. Pierre Jeanniot, director general (CEO) of the International Air Transport Association, "Airlines, Growth, and Iata—A Success Story."
- October 12. José M. Izquierdo, secretary of transportation and public works of Puerto Rico, "A Vision for Public Transportation in San Juan Metropolitan Area."
- October 19. Joseph Barr, Community Development Department, Environmental and Transportation Planning, Cambridge, Massachusetts, "A Local Perspective: Transportation Planning in the City of Cambridge."
- November 2. Jonathon Richmond, author of *The Private Provision Of Public Transport* "The Private Provision Of Public Transport."
- November 9. Kevin Murphy, managing director, Morgan Stanley senior airlines analyst, "The Airline Industry and the Capital Markets: A Wall Street Perspective."
- November 16. Peter Calcaterra, PE MBTA project manager for the urban ring, and James Doyle, AICP, project manager, Earth Tech, Inc., "Transit Improvements in the Urban Ring Corridor."

- November 30. Carol Schweiger, senior associate, Multisystems, Inc, "Intelligent Transportation Systems (ITS): They Are Not Just for Highways."
- December 14. Mike Mulhern, acting general manager, MBTA "Bus Rapid Transit for the Silver Line."
- February 8. John Lanigan, CEO of Logistics.Com, "The State of Logistics Technology: David vs. Goliath, Asp vs. Package Software and Other Stories from the Land of the Start-Up."
- February 15. Scheffer Lang, chairman of the board, Taxi 2000 Corporation, and Ed Anderson, president and CEO, Taxi 2000 Corporation, "Personal Rapid Transit Technology and the Transformation of 21st Century Cities."
- March 3. Ennio Cascetta, Department of Transportation Engineering, University of Naples, "A New Role for Public Transportation Systems: Projects and Experiences of the Regione Campania."
- March 8. Dee Biggs, director of logistics, Welch's, "Issues and Opportunities in the Grocery Industry Supply Chain."
- March 15. Dennis P. Coffey, manager of business affairs and governmental relations, HNTB Corporation, "Railroads, Highways, Communities and Public Policy."
- March 18. Krish Srinivasan, manager and consultant, "Leading Logistics Companies–Caterpillar."
- April 5. Hank Lavery, president, Lavery Logistics, "Evolution and Future of Electronic Standards in e-Commerce and Supply Chain Management."
- April 5. Dr. Nicole Adler, School of Business Administration, Hebrew University of Jerusalem, "Airline Hub Competition and Profitability in Western Europe—Nash Best-Response Games and the Search for Industrial Equilibria."
- April 9. Dr. Asok K. Chaudhuri, vice president, finance and planning, CSX Corporation, "Quantitative Management: an Industry Perspective."
- April 19. Robert Obee, vice president and CIO, Roadway Express, "Operations Research in Transportation: It Ain't Rocket Science (It's Not That Easy!)."
- April 19. Dr. Anthony Perl, associate professor of political science at the University of Calgary, "Rethinking Passenger Rail Policy in the United States: Before It's Too Late."
- April 26. William Copacino, global managing partner of Accenture's supply chain service line, "Directions in Supply Chain Management."
- May 3. Andrea D'amato, chief, Department of Environmental Services, and transportation commissioner, City of Boston, "Urban Transportation."
- May 10. Dr. Ashish Sen, director, Bureau of Transportation Statistics, US Department of Transportation, "The Bureau of Transportation Statistics: Setting the Direction."
- May 16. Per Heidenreich, founder/CEO of Heidenreich Marine Inc., "Logistics."
- May 17. Martin Knopp, director, Utah Department of Transportation ITS Division, "ITS and the Olympics: Making It All Work."

On January 15, the center held its annual reception for students and alumni in conjunction with the Transportation Research Board annual meeting. The meeting was attended by more than 150 students, alumni and affiliates.

An open house for admitted students was held in April to offer the opportunity to learn more about the center's degree programs in transportation, and to meet some of the faculty and staff. The event was attended by 24 prospective students, and helped many of them make their decision to attend MIT in the fall of 2002.

Affiliates Program in Logistics

The Affiliates Program in Logistics was established in 1981 to develop relationships between MIT and the private sector transportation and logistics industries. The program helps support research that is of particular interest to private sector organizations and which contributes significantly to improved educational programs for private sector management. The Affiliates Program serves its members through a series of symposiums that cover a broad expanse of critical leading edge topics and issues for companies that ship and carry products and materials. Three firms joined the program this year—the New York City Transit joined in May 2001, Physician Sales and Service, Inc. World Medical joined in October 2001, and Tata Steel joined in April 2002.

Integrated Supply Chain Management Program

Since its inception in FY1995, the Integrated Supply Chain Management Program has maintained a small but solid set of sponsors, now including Avaya, Helix Technology, Intel Corporation, Lucent Technologies, Monsanto, and Procter & Gamble. The consortium has been productive in funding research over its seven years of operation, with most recent funding supporting the supply chain visualization project, as well as CTL research in supply chain management. The consortium has recently included events that bring sponsors together at sponsor company locations, and Procter & Gamble hosted the consortium at its Beckett Ridge Institute for Consumer Research in October 2001.

Professional Education

Logistics and Supply Chain Management: Thought Leadership (June 10–14); Airport Systems Planning, Design and Management (September 30–October 4); Modeling and Simulation for Intelligent Transportation Systems (July 29–August 2); Individual Choice Behavior: Theory and Application of Discrete Choice Analysis to Consumer Demand and Market Share (June 10–June 15); Modeling and Simulation for Intelligent Transportation Systems (July 29–August 2).

Personnel Changes

Cynthia Barnhart, co-director of the Operations Research Center since 1999, was named co-director of the Center for Transportation and Logistics. Her appointment took official effect on September 1. As co-director with Yossi Sheffi, who has led the center since 1991, Barnhart's primary responsibility is to supervise the educational programs associated with the center—the nine-month Master of Engineering in Logistics program (MLOG), the two-year Master of Science in Transportation program (MST), and the PhD program in transportation. Barnhart is, herself, an alumna of the last two programs.

At the end of summer 2001, Tom Sheridan, Ford professor of engineering, became the Ford professor of engineering emeritus, marking a change in his longtime association with the center. While Sheridan continues to participate in MIT AgeLab research, his Human/Machine Systems Laboratory closed, and two of his projects in advanced rail systems were taken over by Jim Kuchar, associate professor of aeronautics and astronautics.

Masha Maltz has been added to the center's staff to support the driving research at the AgeLab.

Recognition

Five of the center's affiliates were honored at the annual meeting of INFORMS, the Institute for Operations Research and the Management Sciences.

Professor Amedeo Odoni was awarded the Robert Herman Lifetime Achievement Award in Transportation Science, granted to an individual who throughout his or her career has made fundamental and sustained contributions to transportation science, and has influenced the field through his or her writings, teaching, service and nurturing of younger professionals.

MIT student Joan Walker won first prize for her dissertation "Extended Discrete Models: Integrated Framework, Flexible Error Structures, and Latent Variables," and Professor Andrew Armacost and alumnus Jon Bottom also won honorable mentions in that competition. Armacost won first prize in the George B. Dantzig dissertation competition—which honors the best dissertation in any area of operations research and the management sciences—for "Composite Variable Formulation for Express Shipment Service Network Design." Arnold Barnett, George Eastman professor of management science at MIT's Sloan School of Management, won the Expository Writing award for demonstrating a consistently high standard of expository writing.

Joseph Sussman, JR East professor of civil and environmental engineering, was named the 2001 recipient of the Roy W. Crum Award by the Transportation Research Board. Sussman was honored at the annual meeting in January for his significant contributions to research on railroads, intelligent transportation systems and other large integrated systems. His influential research on railroads has focused on operations, maintenance, service reliability, and risk assessment for freight and high-speed passenger service. He currently serves as the director of the AAR Affiliated Laboratory at MIT.

Sarah Bush, a PhD candidate in transportation, was named Outstanding Student of the Year 2002 by the New England University Transportation Center at MIT. She was selected based upon a regional competition that included graduate students from MIT and Harvard University plus the six New England state universities. She was honored, along with all of the national UTC award winners, at a US DOT special awards ceremony in Washington DC in January 2002.

Henry Marcus, professor of marine systems in MIT's Department of Ocean Engineering, was appointed to the Marine Transportation System National Advisory Council (MTSNAC). Chartered by the Department of Transportation in January 2000, the council serves as a non-federal deliberative body to advise the secretary on matters related to the marine transportation system—waterways and ports, and their intermodal connectors.

Cindy Barnhart, Co-Director and Professor of Civil and Environmental Engineering
Yossi Sheffi, Co-Director and Professor of Civil and Environmental Engineering and of Engineering Systems

More information about the Center for Transportation and Logistics can be found on the web at http://web.mit.edu/ctl/.

Industrial Performance Center

The MIT Industrial Performance Center (IPC) is dedicated to the study of industries in the United States and in other advanced economies. The center brings together the intellectual resources of MIT in a search for fresh insights into the nature and origins of successful industrial performance. Through our research we seek to help leaders in business, labor, government, and the universities better understand global industrial development and to work with them to develop practical new approaches for strengthening

public policies, business strategies, technical practices, and educational programs. With the participation of about 30 faculty members and more than 50 students from every school, the center today serves as a listening post on industry, monitoring and interpreting industrial trends, techniques, and patterns of organization.

Research Highlights

The center's research is organized around three major themes: technology and the changing American workplace; systems and strategies for innovation; and globalization and its implications for industries and societies.

This year the center launched a major new research program on local innovation systems. An international team of researchers led by Professor Richard Lester is studying the conditions of innovation in selected industries in more than a dozen regions around the world, including locations in the United States, Finland, Japan, Taiwan, Ireland, and Israel. A particular focus is on the role of research universities as contributors to innovation and economic growth in these regions. The team includes researchers from the University of Tampere, Helsinki University of Technology, and the University of Tokyo as well as the IPC, and is sponsored by government agencies in several countries.

The center continues its studies of globalization. The term globalization refers to the set of changes in the international economy that are tending towards the creation of a single world market for capital, goods, and services. In each of these dimensions, globalization raises new challenges for sustaining innovation, growth, societal well being, and broad political legitimacy in the nations it encompasses. The IPC globalization study focuses on one aspect of these developments: the fragmentation of the production systems of firms in the advanced economies, and the relocation of parts of these enterprises to other societies. Research on this topic is currently underway in the United States, Europe, Japan, Mexico, China, Taiwan, Indonesia, Thailand, Malaysia, and Latin America. The IPC globalization study team is led by Professor Suzanne Berger (Political Science), and also includes Professors Tayo Akinwande (Electrical Engineering and Computer Science), Don Lessard (Sloan), Richard Lester (Nuclear Engineering), Charles Sodini (Electrical Engineering and Computer Science), Edward Steinfeld (Sloan), IPC research associate Tim Sturgeon, and several doctoral students, and also includes research affiliates from Germany, Japan, and Taiwan. As part of this research, a World Bank-sponsored study of East Asian supply chains in the electronics, automobile, and apparel industries was conducted by Professor Richard Lester, Dr. Tim Sturgeon, and several IPC graduate students.

This year the IPC received a founding grant from the Hewlett Foundation for a second research initiative related to globalization. The Globalization, Economic Development, and Standards Project focuses on the investment and contracting practices of multi-national corporations in emerging economies, the implications of these practices for sustainable economic development, and the role of labor and environmental standards and related codes of conduct. The research is led by Professor Richard Locke (Sloan and Political Science), and participating faculty include Professors Joshua Cohen (Political Science), Thomas Kochan (Sloan), Robert McKersie (Sloan), Michael Piore (Economics), Dara O'Rourke (Urban Studies and Planning), Judith Tendler (Urban Studies and Planning), and Balakrishnan Rajagopal (Urban Studies and Planning).

People

Visitors to the IPC this year included Patrick Le Quement, senior vice president for corporate design at Renault, who delivered a series of lectures and seminars on creativity in design and management; Professor Alok Chakrabarti, founding dean of the School of Management at the New Jersey Institute of Technology, who held a Sloan Industries Fellowship at the center for 2001–2002; and Ms. Helene Grela, of the Institute d'Etudes Politiques in Paris, who conducted research on outsourcing in the automobile industry.

Professor Suzanne Berger was a visiting professor at Ecole Polytechnique and at Sciences Po in Paris in 2001–2002 and presented lectures on globalization at several leading universities throughout Europe. Her book based on these lectures, *Le Première Mondialisation*, will shortly be published by Editions du Seuil.

During academic year 2001–2002 the center awarded three new IPC doctoral fellowships. Raja Shankar received a fellowship to pursue his research on economic development through local knowledge accumulation by studying the Indian software industry. Sarah Kaplan was awarded a fellowship to carry out her research on how firms make strategy in periods of high technological uncertainty. Xudong Gao received a fellowship to pursue his research on explaining different patterns of technological capability development in China's electronics industries.

Also this year, IPC doctoral student Douglas Fuller was awarded a Fulbright scholarship to continue his research on innovation and industrialization in China and Taiwan; and IPC doctoral student Carlos Martinez-Vela received a Martin fellowship in sustainable development.

Richard K. Lester
Director
Professor of Nuclear Engineering

More information on the Industrial Performance Center can be found at http://web.mit.edu/ipc/www/.

Center for Innovation in Product Development

The Center for Innovation in Product Development (CIPD) links representatives from academia, industry, and government who share our dynamic vision of the future of product development—new products will be developed by just-in-time collaborations of globally distributed teams linked seamlessly by web-based tools and processes. These collaborations will be formed by means of a services marketplace, where lead firms will find the world's best suppliers of information, components, and support services.

CIPD's mission is to lay the conceptual groundwork for, and contribute core components to, a product development infrastructure that will help companies to thrive in the new services marketplace. Using industrial sites as our laboratories, we work with engineers and managers in product development environments to extend our understanding of the product development process, and provide innovative improvements to current practice.

CIPD was established in 1996 as one of the NSF's Engineering Research Centers (ERC), and is an interdepartmental research program joining MIT's School of Engineering and Sloan School of Management. Since its inception, CIPD has executed nearly 200 research projects, and produced over 133 refereed journal articles, 90 conference papers, and received 21 awards for outstanding research. That research has led to the creation of 11 spinoff companies, with an estimated 135 employees. In addition, the center's PD21 program has produced new degree programs at three partner universities. In FY2002, CIPD's 18 faculty and 21 graduate students have pursued product development research with a budget of $1.5 million.

As noted in last year's report to the MIT president, NSF elected not to continue funding CIPD as an ERC beyond December 31st, 2001. We have had two years to prepare for this change, and have successfully transitioned by completing the ancillary programs required of an ERC, and focusing our research on problems specific to our sponsors. Under the guidance of center director Chris Magee and assistant director Nils Nordal, CIPD continues to advance the theory and practice of product development with research programs exploring the complex systems aspects of product development.

Research Programs

With the conclusion of our obligations to the NSF, the center has evolved over the past two years away from the ERC model of research—with its numerous ancillary commitments and programs—to one of focused research on specific problems. Increasingly, we have applied our research efforts to projects of particular interest to individual sponsoring companies, projects that provide direct benefits in terms of the understanding of and solutions to current problems.

Many of these projects are related to the emerging field of engineering systems—the study of systems characterized by their especially large scale, great complexity, and high or varying rates of change. The bulk of our research projects during the past five years—especially those in our core initiatives—have provided a natural gateway toward this focus. Our core initiatives explore characteristics of the design, development, and management of complex systems, a concern of increasing importance to contemporary engineering. Our evolution in this direction was reflected most recently in the Engineering Systems Division (ESD) symposium held in May of 2002—CIPD director Chris Magee not only presented research, but also served on the Symposium Committee.

CIPD research is directed by our vision that product development will be dispersed, global, and driven by new information and communication technologies. CIPD's four core research initiatives are:

- Distributed Object Modeling Environment (DOME)—Professor David Wallace, lead
- Information Flow Modeling (IFM)—Dr. Daniel Whitney, lead
- Virtual Customer (VC)—Professor John Hauser, lead
- Platform Architecture (PA)—Professor Olivier L. De Weck, lead

Distributed Object Modeling Environment

DOME represents a fundamentally new approach to integrated modeling and simulation. Our first test bed, DOME can integrate the development efforts of many product designers working on radically different platforms in widely dispersed locations. In a user-friendly web-based environment, DOME allows all designers to participate simultaneously in the modeling process.

Numerous firms have mounted system integration efforts using both commercial and proprietary techniques. These efforts have achieved limited success because of the difficulty in creating an explicit model for a very large system—many suppliers, a rapidly changing product, and an evolving organization.

DOME, however, exploits advances in information technology to create an architecture addressing those barriers. DOME's single environment can integrate both data and services—both product models and simulations—to accurately predict and model integrated characteristics of large, complex, rapidly-evolving products. While maintaining information integrity, DOME provides management controls of a centralized system while providing responsiveness of a locally autonomous system.

The goal of the DOME project is to create a global community—or marketplace—of individuals that offering access to simulation services related to their own specialties. Much as the world wide web enables global access to static information, DOME seeks to provide global access to simulation services through a World-Wide Simulation Web (WWSW).

In 2001–2002, the DOME project has focused on developing a Mosaic-level application to enable widespread, grassroots use of the WWSW. (Mosaic was the university-developed application that allowed non-expert use of the WWW and eventually led to the formation of Netscape Communications.) Our effort has involved the design of a new software architecture based upon the experience gained through previous pilot studies, the development of an open, cross-platform software application, and the design and implementation of appropriate user interfaces and documentation. DOME's third-generation implementation is now approaching readiness for initial deployment.

The focus of the DOME project in 2002–2003 will be to bring the WWSW technology to grassroots innovators, academics, and entrepreneurs. Additionally, we will concentrate on pilot applications with the Ford Motor Company and with researchers at the University of Tokyo. Lastly, we will conduct research into new mechanisms for searching for desired simulation behaviors on the WWSW. For more on the DOME project, visit the CADlab web site at http://cadlab.mit.edu/.

Information Flow Modeling

CIPD is developing advanced methods for the management of knowledge used in the engineering design process. These methods are based on the techniques of information flow modeling through the application of design structure matrices (DSMs). The resulting visual representations of development activities serve as maps for understanding and improving the PD process.

IFM research helps engineers and managers to achieve greater value in the development cycle of complex products. Over the coming year we will complete the development of decision support tools that will allow product developers to reduce risks in the PD process and optimize product performance (with specific application to jet engine design). This work has special significance to the DOME initiative, which began collaboration in the fall of 2000. Thesis work in this area began in the spring of 2002.

IFM research on spiral development aims to determine which conditions warrant use of spiral product development processes rather than stage-gate processes. We laid the groundwork for our investigation during the past year by rigorously defining the spiral and stage-gate processes. In the summer of 2001 we began applying mathematical models to spiral processes at Verizon, and completed that work in the fall. Also in the summer of 2001, we completed a case study on spiral applications in the computer hardware industry for ITT Industries. Additionally, we completed case studies of Ford, Pratt & Whitney, IDE, and Xerox. By the spring of 2002, we began to determine the selection criteria necessary to effectively choose between spiral and stage-gate product development processes.

IFM research on system level knowledge strives to increase our understanding about the capture and management of design knowledge in complex products. Using DSM, we map out the exchange of knowledge during a project's early development. Our aim is to better convert top level specifications into component specifications, and to ensure that components in complex systems work harmoniously. Collaborations between Ford, Pratt & Whitney, Otis Elevator, and Veeco-CVC have proven the value of our novel uses of DSM. In the summer of 2001 we conducted a case study at Johnson and Johnson, and concluded analysis in the fall. Deliverables included a paper presented the ASME 13th International Conference on Design Theory and Methodology in September.

Virtual Customer

The phenomenal advances of the internet in recent years now allow marketing research to be fully integrated into the PD process. Our virtual customer projects are designed to make both the customer and the PD teams full participants in a dynamic exchange of information that benefits both. The projects pursue a radically reduced lag time between customer input and PD response, and at a fraction of current cost.

Demonstrations and working papers are available at the Virtual Customer web site at http://mitsloan.mit.edu/vc/. This site is a major practical output of the project, and includes demos of various VC methods. It is also posts open-source code that will allow researchers and practitioners to download software applicable to market research. This past year, we made significant progress on our five virtual customer methods—user design, securities trading of concepts, information pump, fast polyhedral adaptive conjoint analysis, and reinforcement learning, as highlighted below.

User Design (UD)—Developing and Testing an Interface for Product Development

This project aims to gather better data faster by directly engaging customers in the design process. We have developed a full suite of UD methods, testing applications for products such as crossover vehicles, ski resorts, telemetrics, laptop computers, and laptop computer bags. The computer bags experiment suggests that UD is both internally and externally valid as a predictor of customer behavior; in the coming year, we will complete analysis of the study to verify it.

In addition, we are developing software engines that allow product development teams to rapidly create User Design web sites. These engines will enable the teams to rapidly gather feedback on customer questions. We tested pseudo-engines using eight student projects. (NFO Interactive donated access to their panel for the test.) Over the coming months, we will provide open source code to encourage a panel company, market research company, or sponsor to further refine these engines. Our ultimate goal is to deploy an engine that will allow design teams to quickly and inexpensively create their own customer questionnaires.

Securities Trading of Concepts (STOC)—Using Web Markets to Evaluate Product Concepts

STOC offers a creative approach to product concept evaluation that uses financial market methods. A small panel of respondents plays a game trading "securities," each of which represents a product concept. A highly valued security is equivalent to a desirable concept, and therefore, marketplace success.

As reported in last year's annual report, we completed a pilot test of this web market methodology using portable bicycle pumps as the product category. In 2001 we extended the STOC concept to laptop computer bags and cross-over vehicles (one part SUV, one part minivan, one part car). We anticipate working with one of our industry sponsors (discussions are underway with Ford) to test STOC markets on actual product concepts, and to compare results to those of current forecasting methods.

Information Pump—Getting a Better Voice of the Customer

Methods that elicit qualitative information from consumers presume a good faith effort on the part of the customer. However, consumers do not always fulfill that expectation, so the Information Pump (IP) provides incentives. This project seeks to develop a discussion protocol that provides, for the first time, a set of clear incentives for revealing all relevant information about a target product.

In 2001 we refined and tested several web-based variants of the IP. We can now run multiple discussion sessions from a single server, which can accommodate up to seven participants. We also developed an individual respondent control procedure, which determines information quality. In 2002 we are extending the IP in three different directions. First, we will develop an asynchronous version that will enable PD teams to use the IP to passively and continuously collect voice of the customer information over the web. Second, we will provide a solution to the theoretical problem of creating incentives for closed-ended evaluations supplied by a client. Third, we will explore ways of adapting the IP to idea generation.

Fast Polyhedral Adaptive Conjoint Estimation (FastPace)—Reducing the Questioning Burden with Advanced Polyhedral Methods

Normal conjoint methods are too long for web-based applications. (Respondents "wear out" sooner on the web.) However, marketing research shows that adaptive conjoint methods *can* be effectively applied. In 2001, the Virtual Customer initiative continued to work with leading firms that use adaptive conjoint analysis (ACA), and to refine their methods with new interior-point algorithms drawn from mathematical programming.

In the latter part of 2001, we undertook a large-scale experiment to test the external validity of FastPace, as compared with ACA and traditional non-adaptive methods (this test was one of the first controlled external validity tests for any of the methods, even given the thirty-year popularity of conjoint analysis). FastPace demonstrated greater internal and external validity, and provided superior predictions.

More importantly, as we discovered during the experiment, hybrid methods could perform even better. Using a version of the FastPace code coupled with new theory, we developed a hybrid adaptive method that provides estimates for individual respondents. In 2002 we will develop and test the algorithm with simulation and empirical studies. A key aspect to this development will be an error theory.

Reinforcement Learning

All the methods we have explored to date—web-based conjoint analysis, FastPace, User Design—seek to collect information at the level of the individual customer. This past year we identified the process of reinforcement learning for developing super-adaptive methods, which would handle much larger numbers of customers and product features. In the super-adaptive scenario, product designs would evolve automatically as more customers completed survey tasks about those designs.

In the latter half of 2001 we began applying algorithms to data supplied by a collaborating firm (a catalogue company). Our goal since then has been to find a means to select products, prices, and promotions automatically to maximize profit. Once we understand the algorithms and their capabilities, we plan to apply them to develop the super-adaptive methods. Working papers will follow.

Platform Architecture

As noted in last year's Report to the President, our PA initiative was successfully completed in May of 2001. The initiative was revived, however, in the summer of 2002 under the leadership of Professor Olivier de Weck. In keeping with CIPD's goal of increasingly focused research for center sponsors, this initiative is helping General Motors to develop comprehensive and dependable system architecture principles for vehicle family design.

Motor vehicle companies worldwide are seeking to optimize the numbers and types of vehicle platforms; the goal is to reduce production costs and development time while maintaining diversity of product variants. Increasingly heterogeneous customer demands have driven the trend towards a fragmentation of the world automotive market for cars and trucks with smaller per vehicle sales volumes. Success in this competitive environment requires the research and application of sound system architecture principles in vehicle family design. General Motors in particular—the world's largest automobile company, with sales in 2002 of 8.5 million vehicles and 12 different brands—faces a daunting challenge due to its diverse product family.

CIPD is increasingly interested in the PD aspects of engineering systems, and this project is assisting General Motors to develop a methodology for platform system architecture of its vehicle families. Begun in June 2002, this project will, over the next year, establish a baseline of current vehicle platform architecture practices at GM, determine the constraints used for system architecture optimization, then begin preliminary vehicle platform architecting with application to a specific GM vehicle family.

Other Research Highlights

New Initiative: Tools for Risk Management in Product Testing

An important problem in product development is the formulation of a best value testing strategy—a key measure for reducing product development costs and time to market. To evaluate new design concepts and determine the performance of products under development, industry carries out numerous tests and simulations. However, real-world testing is always less than perfect, and can never fully resolve the uncertainties related to a given design. We must therefore analyze the tradeoffs between the various tests to determine a testing plan that maximizes confidence level while minimizing the testing cost and cycle time. In other words, we need to determine a best value testing strategy.

This project seeks to evaluate and apply a probabilistic method proposed by MIT professors Earll Murman and John Deyst. It treats testing as an activity that generates useful information about design parameters, and reduces the uncertainty of satisfying product performance requirements (i.e., risk). By quantifying the risk reduction of testing activities, and counting testing cost/time, we will identify and implement the most cost-effective investment strategy to balance risk management with resource investment in testing.

The project will focus on the testing of a hood system for the Ford Motor Company. Initiated in spring 2002 with the collection of modeling data, the project will apply a model to test cases during the summer, report interim results, then complete the project and deliverables during AY2003.

Completion of Initiatives

In May 2002, CIPD successfully completed the following three research initiatives:

- Incentives and Boundaries
- Implementation Dynamics
- Product Development Integration Laboratory

With the conclusion of their research and theses, and their subsequent graduation from MIT, the graduate students in these initiatives assumed positions in industry and academia.

Education Programs

CIPD is an interdisciplinary program between the School of Engineering and the School of Management. We believe that students' course experiences should address the interplay between the technical, social, and system elements of product development, and prepare them for work in a globally distributed services marketplace. In the period from From July 1, 2001 to June 30, 2002 CIPD funded nine master's students and 13 PhD students. In June 2002, MIT awarded six master's degrees and PhD degrees to students funded by the center.

Our PD education programs currently target three communities: working professionals, graduate students, and undergraduates, as outlined below.

Programs for Working Professionals

SDM Product Development Track

The SDM Product Development Track was created in collaboration with MIT's System Design and Management (SDM) program. This two-year degree program targets mid-career engineering professionals who are potential leaders in product development. Students in the program continue to work for their employers at least half time while pursuing their degree through an innovative educational structure—courses are broadcast directly to the students' company sites. Several times per year, students visit MIT to participate in special PD course modules, and for one semester in their program, students study on campus. At the course's completion, students receive an MIT degree in engineering and management.

To date, 40 MIT faculty have participated in the SDM track. Approximately 270 students from 55 organizations have enrolled, and nearly 200 have graduated. In 2002, those organizations included Boeing, Ford, Kodak, NASA, Raytheon, and UTC among many others. SDM plans to keep its cohort at approximately 30–40 students per year using the current format.

SDM is renovating two of its core courses: CIPD director Chris Magee has joined the teaching roster of ESD.33J Systems Engineering; Professor Steven Eppinger of the center's IFM initiative has joined the roster of ESD.185J System and Project Management.

Additionally, Professor Eppinger assumed responsibility as Sloan codirector of LFM-SDM in July 2001. With closer ties to these two programs, CIPD has explored arrangements whereby LFM-SDM partner companies would sponsor CIPD doctoral students in conjunction with their LFM-SDM Master's degree internships.

PD21 (Education Consortium for Product Development Leadership in the 21st Century)

CIPD began disseminating the SDM product development curriculum in 1998. Collaborating with the University of Detroit Mercy, the Rochester Institute of Technology, and the Naval Postgraduate School, we implemented the program called PD21, the Education Consortium for Product Development Leadership in the 21st Century. Guided by our industrial sponsors Xerox, Ford, and the US Navy, the schools copy MIT's core PD curriculum from SDM, but emphasize project and case study work relevant in their geographic areas (optics in Rochester, automobiles in Detroit, naval systems in Monterey).

Establishing the consortium as a multi-institutional platform for PD education has been a clear success. To date, over 450 students have enrolled in the program at the three schools, and over 200 have graduated. With the PD21 program firmly established, CIPD completed its obligations with regards to the NSF grant that initiated it. The center submitted its PD21 final report to the NSF in November of 2001, and it was approved in December.

Executive Education Courses

CIPD faculty created and are teaching a full suite of short courses as non-degree programs. These industrial mini-courses (generally a dozen annually) have been offered throughout the year through MIT's office of summer professional programs and through Sloan's office of special executive programs. Well over 300 students have attended during the past academic year. In addition, SDM faculty have offered over a dozen courses by distance learning through the SDM Product Development Track.

Systems Engineering Course

In June 2002, CIPD's director Chris Magee began co-teaching the course ESD.33J Systems Engineering. With 42 graduate students enrolled (most in the SDM Product Development Track), the course examines the sources of complexity that can adversely affect new product design and development, and establishes a systems engineering process that can be tailored to mitigate the effects of complexity. Subject materials and exercises are complemented by special event seminars prepared by industry and government speakers. Most recently, the class was visited by the chief of engineering at United Technologies, who discussed the design process of fuel cells.

Programs for Graduate and Undergraduate Students

Graduate Course

Professor Steve Eppinger of the IFM initiative teaches a semester-long class, 15.783J (or 2.739J, or ESD.32J) Product Design and Development. The class focuses on integration of the marketing, design, and manufacturing functions of the firm in creating new products. Student teams develop new product concepts and create prototypes. An associated web site (its construction was supported by CIPD) provides an extensive set of resources for students and support materials for faculty teaching comparable courses at other institutions. The site is organized around the book *Product Design and Development* as taught at MIT, and can be found at http://www.ulrich-eppinger.net/.

MBA Course

CIPD collaborated on the design of a semester-long MBA course based on an integrated theory of the firm. 15.903 Strategy and Organization incorporates the latest (often CIPD-funded) research while analyzing insights from organizational theory and economics. The course was taught for the first time in the fall of 2000, and in AY2002 drew approximately 250 students.

Freshman Course

2.009 The Product Engineering Process teaches undergraduates how to develop an understanding of product development phases by working in teams to design and construct high quality product prototypes. Taught by CIPD initiative leader David Wallace, the class develops students' ability to reason about design alternatives, and apply modeling techniques appropriate for different development phases.

Noon Seminars

In AY2002, CIPD hosted over 20 lunchtime seminars. These informal talks included presentations by researchers at CIPD and throughout the Institute, and also by professors from the Harvard Business School and product developers from industry.

Outreach Programs

The center's outreach activities aim to provide lifelong learning experiences for business professionals.

Third International Design Structure Matrix Workshop

In October 2001, CIPD cosponsored this workshop on DSM along with the Lean Aerospace Initiative, Leaders for Manufacturing, and Ford Motor Company. Over 25 speakers presented research at this highly interactive gathering, which was attended by 60 participants from industry, government, and academia. The fourth international DSM workshop will be held in October 2002.

Business Edge Teleconference

In April 2002, CIPD hosted a satellite downlink teleconference on Business and Design. Approximately 150 participants from a dozen institutions took part in the program, which featured video case studies on successful design in business. Included were interviews with CEOs, senior executives, and designers, who provided insights into corporate design practice at Acela, Humanscale, IBM, OXO International, and SEI Investments. Broadcast from MIT, the program's panel of experts included Professor Stephen Eppinger of CIPD's Information Flow Modeling initiative.

Visiting Scholars

In the past year, CIPD hosted four visiting scholars and research scientists from the Helsinki University of Technology, Ben-Gurion University of the Negev in Israel, and the University of Pretoria.

Other Recent and Upcoming Events

- July 2001. Sloan Executive Program: managing complex product development projects.
- August 2001. Naval-Industry R&D partnership conference.
- September 2001. Sloan Executive Education: developing and managing a successful technology and product strategy.
- October 2001. DOME working group meeting.
- October 2001. ITT Industries annual Taguchi Methods Symposium—This conference explores the role of Robust Engineering in product design through a series of tutorials and case studies.
- October 2001. Third international Design Structure Matrix workshop.
- November 2001. CIPD fall research review.
- November 2001. Sloan Executive Education: managing complex product development projects.
- December 2001. Sloan Executive Education: developing and managing a successful technology and product strategy.
- April 2002. The Business Edge: satellite down-link teleconference.
- May 2002. Engineering Systems Division internal symposium.
- May 2002. Sloan Executive Education: developing and managing a successful technology and product strategy.
- July 2002. Sloan Executive Education: Managing Complex Product Development Projects.
- August 2002. Naval-Industry R&D Partnership Conference. CIPD will attend the conference and participate in the "First Responders Robotics Business War Game."
- October 2002. Fourth international Design Structure Matrix workshop.
- October 2002. MIT Series on Technology and the Corporation—CIPD will present the results of its research in a two-day program entitled "Innovations in Product Development: Bringing Successful Products to Market."
- November 2002. Sloan Executive Education: managing complex product development projects.

Personnel Changes

In January 2002, Chris Magee assumed directorship of CIPD. Professor Magee joined the center after serving as executive director of the Ford/MIT Alliance. His extensive background in product development is the result of many years in R&D for the Ford Motor Company. His strong ties to industrial product development will enhance CIPD's role as a predominantly research-based center.

On December 31, 2001, Professors Maurice Holmes and Steven D. Eppinger stepped down as CIPD's co-directors. Professor Holmes retired from MIT to become president of the Business Process Solutions Group in Rochester, NY. Professor Eppinger will continue his CIPD-related teaching and research duties, as well as his duties as co-director of the LFM/SDM program.

Professor Eppinger's assistant Cara Barber transferred from CIPD to join Professor Eppinger at LFM/SDM.

Nils Nordal continues to serve as assistant director, with Michael Mack as communications coordinator. Kathleen Sullivan continues as the center's

office manager, and has assumed additional responsibilities as manager of finance. Kathleen Wang, after many years with CIPD, left her position as industrial liaison to spend more time with her family.

Nils Nordal
Assistant Director

More information about the Center for Innovation in Product Development can be found on the web at http://web.mit.edu/cipd/.

Artificial Intelligence Laboratory

MIT's Artificial Intelligence Laboratory (AI Lab) added new faculty during the year and embarked in new areas of research. Professor Bill Freeman joined the Department of Electrical Engineering and Computer Science and became a member of the Vision Group within the AI Lab. He is working on fundamental questions of computer vision and graphics. Professor John Leonard of the Department of Ocean Engineering became an affiliate of the laboratory and while not housed in the lab's space, has started collaborations with other laboratory faculty members in the realm of mobile robot navigation and localization.

During the year we also lost a valued faculty member, Professor Gill Pratt, who moved to Olin College of Engineering. Professor Hugh Herr, who holds positions at Harvard and at MIT through Whitaker College, has taken over the Leg Lab within the AI Laboratory.

Professor Tommi Jaakkola initiated new research in machine learning applying techniques to problems in understanding gene regulatory mechanisms. The early results are very promising. Professor Patrick Winston started a new initiative in modeling political processes. Dr. Tom Knight started a new wet biology project in re-engineering the genome of one of the smallest living creatures, a mycoplasma. Professor Rod Brooks started a new research group trying to understand the fundamental organizing principles of living systems with the goal of building a living machine.

Besides these new efforts there were many continuing projects with significant research results. Professor Eric Grimson's visually guided surgery group developed new tools for virtual colonoscopies. Professor Tommy Poggio and his student Tony Ezzat developed a new photo-realistic method for generating movies of real individuals saying or singing things that they had not really said or sung. Dr. Boris Katz and his student Jimmy Lin developed new mechanisms for automatically annotating web pages so that retrieval programs can understand the content of the web pages they search, rather than simply use keyword matching. Professor Randy Davis and his students rebuilt their sketch understanding systems so that they can be applied to new domains, providing a natural interface to existing large software systems. Dr. Howie Shrobe and his students developed systems that can understand meetings between people providing an automatic annotation of what transpires. Professor Trevor Darrell and his students developed new vision techniques to determine head pose, body disposition, lip motion, and sound localization. Professor Brian Williams built new planning and monitoring systems for onboard deep space missions. Professor Berthold Horn worked on new methods for reconstructing medical images from dispersed light sources. Professor Ted Adelson developed new techniques for extracting the properties of materials in images. Professor Leslie Kaelbling developed new learning techniques for mobile robots. Professor Gerry Sussman and his students continued to develop local techniques for large collections of physically distributed computational elements to self-organize spatially.

The disastrous events of September 11 had an impact on the research of many faculty members within the laboratory. We have initiated a number of new projects and project proposals that emphasize extracting patterns from vast amounts of disparate data, in interpreting image sequences of human activity, and in understanding natural-language documents better. The full ramifications of this re-emphasizing of research directions have yet to be fully played out. Clearly there is a transition as the federal government redirects its funding levels to these new problem areas. One concrete result has been the initiation of an effort with the Laboratory for Computer Science to explore the possibilities of deeper collaboration with MIT's Lincoln Laboratory in areas of national defense.

The Artificial Intelligence Laboratory is involved in two large industrial research efforts, both in conjunction with the Laboratory for Computer Science. During this year we completed the fourth year of a five-year research agreement with NTT. We also completed the second year of the Oxygen Project in alliance with NTT, Philips, Nokia, Acer, Delta Electronics, and Hewlett-Packard.

The research funding level for the laboratory was $12.15 million. DARPA provided 56 percent of this funding, while other government sources accounted for 9 percent. Corporate funding, mainly from NTT and Project Oxygen, accounted for the remaining 35 percent. As the effects of the technology sector downturn continue, we expect that it will be very hard to maintain that level of corporate funding beyond this coming year—even if technology sectors experience a significant upturn, we will be affected by a lagging trough in funding.

The total head count for the AI Laboratory was 310 people. This includes 20 full-time faculty, 130 graduate students supported by research assistantships, and 40 supported by teaching assistantships, fellowships, and self-supporting. We had 35 UROPs working at the AI Lab throughout the year. We had 17 research scientists and three research engineers, along with 20 postdoctoral students. We had 12 visiting scientists and 13 research affiliates.

Administrative and support staff included five people on the headquarters staff, seven providing direct assistance to faculty members and eight systems administration staff.

Rodney A. Brooks
Director
Fujitsu Professor of Computer Science and Engineering

For more information on the Artificial Intelligence Laboratory, see the web site at http://www.ai.mit.edu/.

Biotechnology Process Engineering Center

The Biotechnology Process Engineering Center (BPEC), as a National Science Foundation engineering research center, is a multi-disciplinary body with faculty members drawn from MIT's Departments of Biology, Chemistry, and Chemical Engineering, the Biological Engineering Division, and the Whitehead Institute for Biomedical Research; the University of Toronto's Department of Chemical Engineering; and the Brown University School of Medicine's Liver Center.

Goals, Objectives, and Priorities

BPEC remains committed to its core mission of fostering interdisciplinary research and education fusing engineering with molecular cell biology, with emphasis on strategic problem solving and close interactions with the biotechnology industry.

BPEC's NSF-supported strategic plan continues to focus on therapeutic gene biotechnology, with two major engineered-system objectives: an *ex vivo* approach employing genetically engineered stem cells, and an *in vivo* approach employing targeted viral or synthetic vectors. This plan leverages and synergizes with our broader MIT mandate to catalyze research and education at the biology/engineering interface, prominently including the academic unit charged with creating and operating curricular degree programs in this area, the Biological Engineering Division (BE).

The educational programs of BPEC deal with the needs of undergraduates, graduates, and industrial personnel. The goal of the educational programs is to provide integrated and broad bioengineering perspectives to the students. We have energized our student leadership council with new members and activities. At the undergraduate level we have continued to participate in the biomedical engineering minor offered by BE to students in all majors, while at the graduate level we likewise participate in the Bioengineering and Toxicology PhD programs offered by BE along with the traditional PhD programs in the Departments of Biology, Chemistry, and Chemical Engineering.

In addition, NIH training programs in biotechnology and in genomics are administered from the BPEC office, leveraging the NSF ERC to broader educational opportunities at the engineering/molecular-biology interface. Undergraduate research is achieved through the Undergraduate Research Opportunities Program for MIT students and the Research Experience for Undergraduates for non-MIT students. Special one-week summer courses are offered to industrial personnel.

Industrial activities and planning are coordinated through our Therapeutic Gene Biotechnology Industrial Consortium Advisory Board, supervised by our BPEC team of Matt Croughan, industrial liaison officer, and Jean-Francois Hamel, associate industrial liaison officer.

Accomplishments

BPEC successfully passed the NSF critical site review. A new cooperative agreement will be issued for the period from September 1, 2002, to August 31, 2005.

We are on, or ahead of, our strategic plan timeline schedule in both project areas. We have identified exciting new enhancements in each of these project areas, which are helping to accelerate our movement toward the ultimate engineered systems.

We have added a new investigator, Professor Leona Samson of BE and director of the Center for Environmental Health Science, who is a leading authority in the field of toxicogenomics. In addition, we welcomed Professor Alexander Klibanov (Department of Chemistry and BE) as a returning BPEC PI to undertake formulation and clearance studies of the synthetic polymer gene delivery vectors being developed by Robert Langer.

We have added a new degree program in BEH, the Master of Engineering in Biomedical Engineering, which offers an opportunity for students to carry out thesis research in industry.

We have energized our Student Leadership Council (SLC), with new members and activities. We have more than doubled the size of our Industrial Consortium Advisory Board (ICAB), from seven to 18 members, and have received the most strongly positive ICAB SWOT analysis since the BPEC reconfiguration three years ago. We have begun to establish specific research collaborations with ICAB members. We have begun collaborations with Cambridge Public Schools in building K–12 outreach, along with continuing our summer Research Experience for Undergraduate program, and successfully participated in an NSF research experience teachers program. We are formulating conceptual underpinnings of a plan to attain self-sufficiency status within approximately five years.

Overall, we submit that we are making excellent progress in accord with our strategic plan and in response to input from ICAB and SLC.

The duPont MIT Alliance (DMA) funded 17 projects with 16 primary PIs and 33 co-PIs across 11 departments and centers. All projects were represented at duPont's annual TechCon meeting in Delaware in May 2002. In addition, the steering committee approved funding for 20 graduate fellowships: three in biology, biological engineering, and chemical engineering; two in chemistry, materials science and engineering, mechanical engineering, and the Sloan School; and one each in the Department of Electrical Engineering and Computer Science, the Technology, Management, and Policy Program, and the Department of Physics. Three DMA faculty presented a four-day executive tutorial in biotechnology in June of 2002.

A total of 134 people took part in BPEC's NSF research strategic plan during fiscal year 2002. This figure comprises 45 MIT undergraduate lab interns (i.e., UROP students), 46 non-MIT undergraduates who participated in the center's NSF Research Education for Undergraduates program; one Cambridge middle school teacher who participated in the center's Research Experience for Teachers program; 24 graduate students; 26 postdoctoral associates/fellows; 10 visiting scientists, engineers, and industry researchers; eight administrative personnel; two other director- level personnel; and 12 faculty. Some faculty served as executive directors.

Educational Outreach

K–12

The BPEC has established a close collaboration with Dr. Melanie Barron, science department coordinator for the Cambridge Public Schools. A program in the planning stage is a lecture series on biotechnology for middle and high school students and parents. This series is being planned for winter 2002.

One of the new BPEC K–12 outreach programs held during summer 2001 is the Research Experience for Teachers (RET) program in collaboration with Johns Hopkins University's Engineering Research Center for Computer Integrated Surgical Systems and Technology (CISST). It is our aim at BPEC to enrich the experience of selected Cambridge high school teachers supported by a supplemental RET grant from the NSF. During the past summer, Ms. Amy Walsh, a Cambridge middle school teacher, participated in this program under the supervision of Linda Griffith and Jean-Francois Hamel.

The BPEC continues to give tours of its facilities to K–12 students and teachers. An introduction to BPEC and its research is given to each tour group prior to visiting the laboratories. Thirty-five students along with their teachers attended tours throughout during fiscal year 2002.

Graduate Outreach

The NIH Biotechnology Training Program (BTP), now in its 13th year of funding, continues to be administered from the BPEC office, leveraging the NSF ERC to broader educational opportunities at the engineering/molecular-biology interface.

The NIH BTP provides funds to support 20 predoctoral students who will provide future leadership in all aspects of biotechnology and the biotechnology industry. This requires that students be educated more broadly than would normally occur within their own discipline, to solve problems when they work with others from diverse backgrounds. The interdisciplinary program provides a formal mechanism for broader education through specific research, education, and industrial interaction requirements. Activities include a yearly retreat and periodic trips to biotechnology company sites. Currently 26 faculty participate in the program from the Biological Engineering Division and the Departments of Biology, Chemistry, Chemical Engineering, and Mathematics. Professors Griffith, Langer, Lauffenburger, Sherley, Wang, and Wittrup are currently participating in the BTP.

We have also administered an NIH genomic training program during fiscal year 2002.

Administrative Initiatives

Professor Linda Griffith has been appointed as the center's deputy director. In addition, we have named Whitehead fellow George Daley to be team leader for the stem cell gene delivery vehicles project and MIT professor Dane Wittrup to be the team leader for the targeted molecular gene delivery vehicles project.

We have substantially increased the participation of BPEC faculty in events organized by student groups, including the Biomedical Engineering Society (BMES), NOBCHE, and the Society of Women Engineers. Linda Griffith serves as the faculty advisor for BMES and several BPEC faculty have made presentations at BMES seminars and social events. Assisting Professor Griffith in the coordination of the BMES activities is Mr. Daniel Darling.

We had a change in support staff in the center's headquarters office. Filling two already established positions, Ms. Michelle Berry joined the team as the assistant fiscal administrator and Ms. Katrina Haff joined the team as the assistant communications coordinator.

As outlined by NSF policy, the Student Leadership Council (SLC) conducted a Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis. The SWOT was conducted by an anonymous survey sent to all researchers (students and postdoctoral fellows) affiliated with BPEC. The SWOT report was positive but requested that more industrial action between the industrial members and students occur. This point was taken seriously and further industrial involvement has been put into place.

Finances and Funding

As an NSF engineering research center, BPEC had to pass a critical site review December of 2001. We are pleased to report that the center passed successfully and will receive a new cooperative agreement for the period from September 1, 2001 to August 31, 2005.

Future Plans

Outreach

It is BPEC's plan to participate in the Research Experience for Teachers program organized in connection with the NEST program. NSF has provided RET funding for one teacher at BPEC for fiscal 2003. The teacher began work

in July in the laboratory of Robert Langer. Should further funding be obtained, additional teachers will join this program under BPEC's direction. In addition, it is BPEC's plan to continue its outreach to MIT undergraduates through UROP.

We plan to develop a lab where Cambridge first-graders through sixth-graders can come to MIT and spend four hours learning how genetic variability influences responses to toxins. Before attending the lab, students will choose from a list of about 20 substances those they think will kill various kinds of cells (liver cells, brain cells, skin cells). In addition to different cell types, Leona Samson will transfect cells with genes that might either protect against or enhance the effect of the toxin. This project will be used to explain variability among people in the population and how gene therapy might help those people.

The NIH Biotechnology Training Program (BTP) developed a new requirement where trainees will need to complete a two to three-month industrial internship during their BTP appointment.

Research

We are making vigorous moves to ensure that both our stem cell vehicle and targeted vehicle thrusts are strongly connected to the driving forces arising from application of the ultimate engineered systems—those vehicles—to human clinical studies. These moves manifest in tangible action the commitment of our vision to the full scope of gene therapy.

Education

During this past year we have taken another major step forward in our undergraduate educational efforts by establishing a new five-year combined SB/MEng degree program in biomedical engineering. With this program, MIT undergraduates can obtain their SB degree in any major together with a MEng degree in biomedical engineering within an integrated five-year period. The curriculum splices key aspects of the BME minor with some of our BE PhD core subjects, and adds an independent research project leading to a MEng thesis.

One especially exciting opportunity opened up by the MEng is the possibility of students carrying out their thesis research in an industrial setting, such as in a laboratory at one of our ICAB partner companies. We are beginning to pursue discussions with some of our ICAB members about ways to move along this very attractive avenue. (It can be noted here that this might provide one facet of our strategy aiming toward ultimate self-sufficiency status.)

Student Leadership Council

New student representatives along with a new slate of officers are being appointed to the center's Student Leadership Council, which is made up of undergraduates, graduates, and postdocs.

Personnel Information

Leadership in the Field

There are many indicators that BPEC is recognized and respected as a national center in the professional communities. One measure of outreach and leadership is the number of invited presentations to various biotechnology audiences. The 12 faculty members in BPEC during fiscal 2002 participated in 45 seminars at universities, 22 seminars at industries, 28 presentations at national and international conferences, and 2 workshops or short courses.

One very important feature of our leadership in the field of bioengineering is the recognition that our new bioengineering doctoral program in the Biological Engineering Division represents the vanguard in the emerging discipline of bioengineering defined as engineering based on molecular-to-genomic biology.

A particularly telling example can be found in the selection of BPEC director Douglas Lauffenburger to give the opening lecture at the Whitaker Foundation Biomedical Engineering Education summit meeting held in December 2000. This presentation on bioengineering as the central discipline in the field of biomedical engineering was invited by the Whitaker Foundation to outline for the audience—including representatives of the major programs in biomedical engineering and bioengineering nationally and internationally—MIT's educational innovations in this new discipline as a model for emulation.

An additional example was the selection of BPEC's associate director for education, Linda Griffith, to serve as co-chair of the recent NSF/NIH Workshop on Education in Bioengineering, Medical Engineering, and Bioinformatics. At this workshop the key intellectual directions of educational programs in these three areas were critically examined and reported upon.

A second indicator of BPEC's faculty leadership and achievements is a listing of honors, awards, and professional leadership services. As seen below, a significant number of BPEC faculty have been recognized by invited distinguished lectureships across the country, major awards and prizes, and election in professional societies.

A third indicator is the strong interest in hiring BPEC graduates for academic faculty positions at other leading institutions. Examples from the new area of therapeutic gene biotechnology include David Schaffer (assistant professor of chemical engineering at the University of California at Berkeley) from the Lauffenburger laboratory, Daniel Pack (assistant professor of chemical engineering at the University of Illinois at Urbana-Champaign) from the Langer laboratory, and Peter Zandstra, now a BPEC investigator himself as an assistant professor of chemical engineering and biomedical engineering at University of Toronto, having worked as a postdoc in the Daley, Griffith, and Lauffenburger laboratories.

Honors

Robert Langer was the Ullyot Lecturer for the Chemical Heritage Foundation, Clapp Lecturer at Brown University, Julian Smith Lecturer at Cornell University, Mason Lecturer at Stanford University, Herman Beerman Lecturer at the Society for Investigative Dermatology, Millennial Lecturer at the University of Liverpool, Bayer Lecturer at the University of Pittsburgh, and Bayer Stein honorary lecturer at the University of Massachusetts, Amherst. He received an honorary degree from the Catholic University of Louvain, Belgium, a Glaxo Welcome International Achievement Award from the Royal Pharmaceutical Society of Great Britain, and a Millennium Pharmaceuticals Scientist Award from the Millennial World Congress of Pharmaceutical Sciences.

Douglas Lauffenburger was elected a member of the National Academy of Engineering and a fellow of the American Academy of Arts and Sciences. He was named the Skalak Memorial Lecturer at the University of California, San Diego, in the Department of Bioengineering.

Harvey Lodish was made chair of Section 22 (Cellular and Developmental Biology), National Academy of Sciences; served on the visiting committee for the Division of Biology at CalTech; co-organized the Whitehead Institute symposium on molecular machines; and established the Harvey F. Lodish Career Development Chair in the sciences at Kenyon College. He was a distinguished lecturer at the Harvard School of Public Health and the Louisiana State Health Services Center, and served on the scientific advisory board for ZMBH (Center for Molecular Biology Heidelberg), Heidelberg, Germany.

James Sherley received the Samuel A Goldblith Career Development Fellowship.

Daniel I. C. Wang received an honorary doctorate of engineering from the Hong Kong University of Science and Technology.

Jack Wands received an NIH Merit Award, and Peter Zandstra won the Premier's Research Excellence Award and was named to the Canada Research Chair in biomedical engineering.

Publications

Researchers at BPEC produced 122 publications related to the BPEC-NSF strategic plan during fiscal year 2002.

Audrey Jones Childs
Director of Administration

More information about the Biotechnology Process Engineering Center can be found on the web at http://web.mit.edu/bpec/.

Laboratory for Computer Science

The principal goal of the Laboratory for Computer Science (LCS) is to conduct research in all aspects of computer science and information technology, and to achieve societal impact with our research results. Founded in 1963 under the name Project MAC, it was renamed the Laboratory for Computer Science in 1974. Over the last four decades, LCS members and alumni have been instrumental in the development of many innovations, including time-shared computing, ARPANet, the internet, the ethernet, the world wide web, RSA public-key encryption, and many more.

As an interdepartmental laboratory in the School of Engineering, LCS brings together faculty, researchers, and students in a broad program of study, research, and experimentation. It is organized into 23 research groups, an administrative unit, and a computer service support unit. The laboratory's membership comprises a total of just over 500 people, including 106 faculty and research staff; 287 graduate students; 73 visitors, affiliates, and postdoctoral associates and fellows; and 35 support and administrative staff. The academic affiliation of most of the laboratory's faculty and students is with the Department of Electrical Engineering and Computer Science. Our research is sponsored by the US Government, primarily the Defense Advanced Research Projects Agency and the National Science Foundation, and many industrial sources, including NTT and the Oxygen Alliance. Since 1994, LCS has been the principal host of the World Wide Web Consortium (W3C) of nearly 500 organizations that helps set the standard of a continuously evolving world wide web.

The laboratory's current research falls into four principal categories: computer systems, theory of computation, human/computer interactions, and computer science and biology.

In the areas of computer systems, we wish to understand principles and develop technologies for the architecture and use of highly scaleable information infrastructures that interconnect human-operated and autonomous computers. This area encompasses research in networks, architecture, and software. Research in networks and systems increasingly addresses research issues in connection with mobile and context-aware networking, and the development of high-performance, practical software systems for parallel and distributed environments. We are creating architectural innovations by directly compiling applications onto programmable hardware, by providing software controlled architectures for low energy, through better cache management, and easier hardware design and verification. Software research is directed towards improving the performance, reliability, availability and security of computer software by improving the methods used to create such software.

In the area of the theory of computation, we study the theoretical underpinnings of computer science and information technology, including algorithms, cryptography and information security, complexity theory, distributed systems, and supercomputing technology. As a result, theoretical work permeates our research efforts in other areas. The laboratory expends a great deal of effort in theoretical computer science because its impact upon our world is expected to continue its past record of improving our understanding and pursuit of new frontiers with new models, concepts, methods, and algorithms.

In the human/computer interactions area, our technical goals are to understand and construct programs and machines that have greater and more useful sensory and cognitive capabilities so that they may communicate with people toward useful ends. The two principal areas of our focus are spoken dialogue systems between people and machines and graphics systems used predominantly for output. We are also exploring the role computer science can play in facilitating better patient-centered, health care delivery.

In the computer science and biology area, we are interested in exploring opportunities at the boundary of biology and computer science. On the one hand, we want to investigate how computer science can contribute to modern day biology research, especially with respect to the human genome. On the other hand, we are also interested in applying biological principles to the development of next generation computers.

Highlights

Oxygen is a project aimed at inventing and developing pervasive, human-centered computers. It pulls together an abundance of technological resources toward creating a new breed of systems that cater to human-level needs, rather than machine-level details. Oxygen is a collaborative project involving some 150 people from LCS and the Artificial Intelligence Laboratory, as well as researchers from the six companies that form the Oxygen Alliance: Acer, Delta Electronics, Hewlett Packard, Nokia, NTT, and Philips. During the reporting period, Oxygen achieved many notable results, including the development of network infrastructure that enables seamless hand-off from one communication protocol to another, the integration of speech and vision to locate and identify an individual and to support multi-modal interactions, the creation of a programming language and associated compiler that can effectively deal with streaming data, and the development of novel approaches to provide secure information delivery.

The Network and Mobile Systems group has designed and implemented Migrate, a new end-to-end framework for internet mobility. By providing a unified framework to support address changes and disconnectivity, Migrate

allows legacy applications to adapt to today's highly mobile environment, and provides mobile-aware applications with a robust set of system primitives for disconnectivity support, resource conservation, and rapid re-instantiation of network connections. Unlike current internet mobility solutions, Migrate treats disconnection as a fundamental component of mobility, and enables applications to gracefully reduce their resource consumption during periods of disconnection and rapidly resume sessions upon reconnection. Migrate uses dynamic updates to the Domain Name System (DNS) to track host location. Existing TCP connections are retained using secure and efficient connection migration, which enables established connections to seamlessly negotiate a change in endpoint IP addresses without the need for a third party. Migrate allows more efficient "vertical" mobility across different wireless networks.

Wire delay is emerging as the most formidable barrier to the scalability of microprocessors. Current monolithic architectures will not scale beyond the next few process generations. Overcoming this barrier requires a fundamental rethinking of the microprocessor design. The MIT RAW processor attempts to address this challenge by utilizing a simple, tiled architecture that fully exposes the interconnectivity to the compiler. During this reporting period, we have finished the design and implementation of the RAW chip, which has been taped out for fabrication. Wire-exposed architectures require the development of novel spatially aware compiler technologies. In this regard, we have developed StreamIt, a high-level, architecture-independent language for streaming applications. StreamIt exposes the parallelism and communication patterns of stream programs and is a natural fit for wire-exposed architectures. Preliminary results indicate that programs compiled by StreamIt on the RAW chip can achieve considerably better performance on many applications.

The Spoken Language Systems group has devoted considerable research effort towards the integration of audio and visual cues for multimodal human-computer interactions, working collaboratively with researchers at the Artificial Intelligence Lab. For example, a state-of-the-art speaker identification system has been developed and integrated with a face recognition system, so that individuals can be identified more reliably. Furthermore, spoken dialogue systems are enhanced with a vision module capable of tracing mouse and hand movement, so that the system can integrate audio and visual cues and understand utterances such as "Move it over here." The group continues to develop utilities to streamline the process of developing spoken dialogue systems, so that more and more people can create applications on their own. Finally, the group is creating technologies that will enable a user to delegate the computer to monitor tasks off-line, and notify the user appropriately at a later time, such as "Call me when American flight 192 lands in Boston."

The W3C and its now 485 member companies and organizations are laying the foundation for the next generation of the web, which will move this important medium from a web of documents to a web of data and meaning, connecting people, computers and other devices across the globe. Work in web services is defining the architecture, protocol (SOAP 1.2) and service description language (WSDL 1.2) to support application-to-application communications independent of distance, operating systems and programming languages. The semantic web activity is developing specifications (such as RDF) to enhance the current web to present information with well-defined meaning, so that computers and people can better work in cooperation. The W3C is also developing standards to enable new classes of devices on the web that can listen, speak, and understand gestures. Other key efforts focus in areas such web accessibility, internationalization, vector graphics, security, privacy and quality assurance. W3C's technologies will help make the web a robust, scalable, and adaptive infrastructure for tomorrow's world of data, information and knowledge.

Organizational Changes

Victor Zue became the director of LCS in November 2001, following the death of our former director, Michael Dertouzos. Concurrently, Chris Terman was appointed as one of two associate directors, with Anant Agarwal continuing to serve as the other associate director.

Distinguished Lecture Series

The laboratory's Distinguished Lecturer Series was renamed the Dertouzos Lecture Series, in honor of our late director. The inaugural speakers for this newly named series were James Gray, senior researcher and manager, Microsoft Research, Bay Area Research Center; Nadine Strossen, president, American Civil Liberties Union, and professor of law, New York Law School; Kai-Fu Lee, vice president, Natural Interactive Services Division, Microsoft Corporation; and Prabhakar Raghavan, vice president and chief technology officer, Verity, Inc.

Victor Zue
Director
Professor of Electrical Engineering and Computer Science

More information about the Laboratory for Computer Science can be found on the web at http://www.lcs.mit.edu/.

Concourse Program

Personnel Information

Staffing changes for AY2003 are as follows:

- Sekazi K. Mtingwa, Martin Luther King Jr. visiting professor of physics at MIT, will lecture and direct the subjects 8.01/8.012 and 8.02.
- Dr. Jeremy Orloff will be in charge of 18.01A/ .02A recitations and tutorials in the fall, and 18.03 recitations in the spring.
- Dr. Harold R. Larson will be in charge of 3.091 recitations.

We are seeking a new instructor for 18.02 recitations.

All other assignments are as in AY2002.

Teaching and Curriculum

For physics, an unexpected challenge arose when during IAP we were informed by Human Resources that Roberta Brawer (our lecturer and principal instructor in physics) would not be able to continue teaching in the spring term. After a frantic search for a replacement, Dr. James Walpole of Lincoln Lab agreed, with the blessing of the Physics Department (and no more than one week to prepare), to teach 8.02. The experience has been instructive for all parties concerned. Although none of the teaching staff wishes to repeat the experience, the students have been remarkably supportive. Fall term registration was up slightly over fall 2000; spring term registration was up by 65 percent over spring 2001.

For calculus and differential equations, the changes implemented in the previous year proved to be quite effective. Registration in Concourse math courses (18.01A/ 18.02A, 18.02, and 18.03) increased by 75 percent overall compared to AY2001. Student feedback (on the standard Concourse feedback questionnaires) was very positive, and attendance and participation was lively and strong. Budgetary constraints again forced us to have students attend mainstream lectures in 18.01A and 18.02A, with recitations and tutorials in the usual Concourse mode. All 18.02 and 18.03 classes were taught within Concourse as usual. Student selection between the 18.02 and 18.01A/ 18.02A options was rather puzzling; in the mainstream the ratio is 3:2 in favor of 18.02, whereas in Concourse it is nearly 1:3, i.e. clearly in the opposite direction. The strong academic performance of this class is a contradiction of this preference. We will continue to seek explanations.

In chemistry, the experiment of last year (a more physical approach with applications to modern biology) was terminated. The major problem was that the text (*The Elements of Physical Chemistry* by Peter Atkins of Oxford University) did not work as well as anticipated. This year the use of the mainstream 3.091 text and approach was resumed, with special supplements on structure and x-ray diffraction. We expect to develop in the future, supplemental material (mostly relating to structure and thermodynamics) establishing the connection with biology. Registration in Concourse chemistry was at or near the saturation level (54), as it has been in years past.

9.00 Introduction to Psychology (HASS-D, Category 4) continues to be highly successful. As in past years we had to run two sections of this course, as registration was 41 and HASS-D regulations have a maximum section size of 25. Typically, registration is in the 40 to 45 range for 9.00.

21W.731 Writing and Experience (HASS, Phase I WRIT, CI-HW) could not be offered during IAP because the committee on the CI requirement refused to permit the course to be re-offered during IAP. In addition, large numbers of students used IAP to complete 18.02A. Therefore 21W.731 was offered during the spring term 2002. This allowed more students to take the course, but some intensity was necessarily lost, since during IAP the students could concentrate exclusively on writing. However attendance was nearly perfect throughout the term, and improvement in writing skills was striking overall.

21W.747 Rhetoric (HASS-D, Category 2, CI-H) was offered in spring 2002.The new course examined rhetoric in literature, philosophy, psychology and mass media, including film. Jointly taught by a writer in residence (Chris Sawyer-Laucanno) and a psychologist (Jeremy Wolfe), the course examined the use of psychology to persuade and provoke. The papers were well written and sophisticated, the classes were lively and very well attended, and one of the papers won an MIT prize.

Accomplishments

Despite continuing changes in HASS communication and writing requirements, overall registration in Concourse humanities offerings has doubled over the previous year (120 total in AY2002 compared to 59 in AY2001). Some of the increase (exactly eight) is because we now allow upperclass Concourse alumni/ae to take the spring term offerings 21W.731 and 21W.747.

The following prizes were awarded this year to Concourse students or alumni/ae by the MIT Program in Writing and Humanistic Studies.

- The Ellen King Prize for freshman (essay) writing—second prize to Anna Kuperstein ("Politics and the Misuse of Religion"), honorable mention to Flora Amwayi ("Tightening the Knot")
- The Robert A. Boit Writing Prize (short story)—second prize to Osman Bakr (junior; "The Gate"); third prize to Nathaniel K. Choge (senior; "Bread")

A former Concourse student who, in his own words as a freshman, told us that he "hated to write and was scared to death of it," will soon see the publication of his second book. Yanni Tsipis, now a graduate student in civil engineering, reluctantly signed up for the class Reading and Writing the Essay in the spring of 1998. Some of his essays for this class, in collected form, won the Boit Manuscript Prize at MIT in 2000. His first book, *Boston's Central Artery*, was published (Arcadia Press) two years ago. His second, *Building the Mass Pike*, will be printed this year. (See *Tech Talk*, March 6, 2002.)

Finally, we note with pride that Paul Njoroge (Concourse 1996) has been awarded a Rhodes scholarship.

Future Plans

21W.746 Humanistic Perspectives on Medicine will not be offered in AY2003 but will be offered in the future, after the HASS-D and CI standings of this course have been established. In the spring term 21W.731 and 21W.735 will be offered. No major modifications in the other Concourse offerings are planned.

We expect to continue to permit upperclass Concourse alumni/ae to register in 21W.731 and 21W.735 in the spring term, as long as we have space available. The results have been excellent in every sense—educational, communal, and resource utilization.

Longer-term plans are evolutionary in nature, including interactive approaches to the teaching of introductory psychology (9.00), which was funded by the Class of 51/55 Funds for Excellence in Teaching; and the development of an extended program for Concourse alumni/ae to continue the growth of the communal skills acquired in the first year.

Robert M. Rose
Director
Professor of Materials Science and Engineering

More information about the Concourse Program can be found online at http://web.mit.edu/concourse/.

Laboratory for Electromagnetic and Electronic Systems

The mission of the Laboratory for Electromagnetic and Electronic Systems (LEES) is to serve as the focus for research and teaching in electric energy from its production through its processing to its utilization, and in electromechanics from the macroscopic through the microscopic levels. Electric energy and electromechanics are defined broadly to include power systems monitoring and operation; automatic control; power electronics; high voltage engineering; and conventional, continuum and biological electromechanics.

Much of the work of the laboratory is experimental, and industrial sponsorship represents a large fraction of the laboratory's support. The laboratory's professional staff consists of seven faculty members from EECS, one principal research engineer and two research scientists, and approximately 50 graduate students. The laboratory faculty and most of the staff are heavily involved in both undergraduate and graduate teaching.

Faculty from the Departments of Mechanical Engineering (ME), Chemical Engineering, Materials Science and Engineering, and Nuclear Engineering are collaborators in many of the laboratory's programs, and there are extensive joint activities with the Microsystems Technology Laboratory, the Gas Turbine Laboratory, and the Laboratory for Information and Decision Systems.

Automotive Electrical and Electronic Systems

Professor John G. Kassakian, principal research scientist Dr. Thomas A. Keim, and assistant professor David Perreault lead the laboratory's work in automotive electrical and electronic systems. This work is sponsored primarily through the laboratory's Consortium on Advanced Automotive Electrical and Electronic Components and Systems.

The consortium, representing almost all of the world's major automobile manufacturers and component suppliers, is truly global, with more Asian-based member companies than North American companies, and a substantial European representation. The consortium has facilitated international working groups addressing issues of safety, battery/
connector design, and arcing faults—all challenges that must be met for the deployment of advanced 42-volt electrical systems. This year the laboratory's work through the consortium has manifested itself in the first production vehicle containing a 42V electrical system, the Toyota Crown, a luxury vehicle marketed in Japan.

Professor Perreault, Dr. Keim, and graduate student Juan Rivas have continued to investigate low-cost methods to improve the output of automotive alternators at idle speed. Professor Perreault and graduate student Gimba Hassan are demonstrating the ability to control the flow of alternator output power to buses at two different voltages, again using a very low cost circuit. Professor Perreault and visiting engineer Dr. S. C. Tang are working on packaging these improvements in automotive alternator packages. All this work complements the work in earlier years by Professor Perreault and former graduate student Vahe Caliskan to improve alternator output at cruising speed. This work has great potential to facilitate high-power electric systems in future automobiles. This year a patent was issued for the Perreault/Caliskan work, and a filing was made for the Perreault/Keim work.

Professor Kassakian, Dr. Keim, and graduate students Woo Sok Chang and Tushar Parlikar continue to develop an innovative electromagnetic drive for engine valves. This new design uses a nonlinear mechanical element to minimize electric power requirements and provides soft landing as an inherent feature of the design, rather than as an objective to be achieved by control system action. The superior behavior of this valve system design has been verified by detailed simulation, and a laboratory prototype is presently under construction. A number of car manufacturers and suppliers have expressed strong interest in this work, which is currently supported by internal funds. A patent filing describing this design has been made this year.

Professors Kassakian and Perreault, Dr. Keim, and graduate student Ivan Celanovic are investigating the rmophotovoltaic converters for automotive electricity production. Multilayer dielectric stacks functioning as selective bandwidth filters show great potential to enhance the performance of such systems. This work has experienced increasing interest from consortium members as auto companies begin to introduce vehicles whose engines turn off when the vehicle is stopped, as in the Toyota Crown.

Professor Perreault and graduate student Gimba Hassan have developed a new alternator design that simultaneously regulates two outputs at different voltages. This new dual-output alternator can supply power to both outputs while maintaining optimal load-matched power generation capability and providing tight transient control of both outputs. The high performance of the approach, which incorporates a dual-output switched-mode rectifier, has been demonstrated experimentally. It is anticipated that this new approach will facilitate the rapid introduction of dual-voltage electrical systems in automobiles.

Professor Jeffrey Lang, Dr. Keim, and graduate student David Wentzloff are completing the experimental characterization of an integrated starter generator for future automobiles. Such a machine can perform both the functions of the present starter and of the present

generator, and can generate at higher power for future automotive loads.

The consortium completed a year-long strategic planning process. In response, several investigations were successfully concluded, and four new studies were initiated. The new studies are advanced automotive power electronics, automotive applications of ultra-capacitors, battery modeling, and heat-driven air conditioning.

The consortium held meetings in Los Angeles and Kyoto in the past year. Registration at both meetings was strong, with Kyoto, having almost 400 attendees, representing the largest registration of any consortium meeting to date. A third meeting scheduled for October 2001 had to be canceled because of the September 11 attacks.

The work of the consortium has been featured in numerous trade publications, including a feature article in *Mechanical Engineering*, the mass membership publication of the American Society of Mechanical Engineers.

Modeling, Monitoring and Control of Power Systems

Utility industry restructuring has placed an intense focus on achieving economically optimal system operation by employing new and more sophisticated control and monitoring strategies. LEES has been making significant contributions to the solutions of problems of power system modeling, economic control, and apparatus monitoring.

Monitoring of Power Apparatus and Systems

Professor Steven Leeb, in collaboration with Professor Les Norford in the Architecture Department, continues the aggressive load monitoring program in California to identify conservation opportunities that could mitigate problems with the state's electric energy supply. This year they completed a field upgrade of all monitoring sites. For example, in Los Angeles county, a county courthouse and several other municipal buildings were instrumented not only with NILMs but also with additional hardware to record detailed environmental conditions in the buildings. This equipment records "fine grain" temperature information in the buildings, sunlight on the surfaces of the buildings, and other environmental data that impacts the operation of the HVAC plant in these buildings. Doctoral students are using these data to test the hypothesis that information from the NILM, with no other sensors, can be used to estimate the mechanical state (temperatures, air flow, etc.) in the building. The installed sensors will be used for measuring these quantities to compare the actual building behavior with predictions from the NILM. If this system works, it will be possible to predict the environmental conditions in a building with very few sensors, and use this information to minimize the energy needed to preserve occupant comfort.

Under a project sponsored by Entergy Services Inc., Dr. Chathan Cooke and his graduate student Timothy Cargol (now graduated) developed the technology for in-service measurement of key oil indicators in high voltage electric power system apparatus. They have achieved the first operating in-service oil dielectric strength integrity (DSi) monitor which solves a problem which has been a reliability bottleneck for over 40 years. Oil dielectric breakdown strength is an important factor in the health and routine maintenance of virtually all oil filled electric power apparatus. Before the DSi project, breakdown strength could only be measured via extracted oil samples due to the destructive nature of all industry standard tests. In contrast, the DSi system employs a new non-destructive breakdown measurement technology that enables in-service measurements and automatic operation. Oil dielectric integrity is now reported to authorized users at any secure web-connected location without travel to the apparatus site. Problems in the LTC compartment are known to account for approximately 50 percent of the troubles experienced by transformers so this new system can greatly improve reliability while also reducing costs.

The in-service demonstration DSi system has provided excellent results and has worked continuously for one year. Importantly, the demonstration system detected a low-strength alert condition of the LTC oil early in its operation. Confirmed by laboratory tests, the degradation was traced to an unexpected high-level of water contamination. Thanks to the DSi system a high-risk situation was averted by need-based maintenance. The DSi system is now in the process of being commercialized.

Modeling and Control of Power Systems

Professors Bernard Lesieutre (now at Cornell University) and George Verghese, with their doctoral student Ernst Scholtz, have developed innovative ideas for control of electromechanical disturbances in power systems by studying the traveling wave nature of these disturbances. This is in contrast to the conventional view, which treats the disturbances in terms of superpositions of swing modes. With the traveling wave viewpoint, a natural control approach is to regulate the generators at the boundaries so that they extinguish reflections. Preliminary studies, presented at the Power Systems Computation Conference in Seville, Spain, in June 2002, show promising results with this approach.

These researchers, together with master's student Paisarn Sonthikorn, have also developed observer methods for estimating the states of a swing model of a power system, from a limited set of measurements. Such estimation is of increasing interest, with the deployment of so-called phasor measurement units in the field, and the desire to obtain more comprehensive and global real-time assessments of system state, for both monitoring and control purposes.

This research stands in contrast to what currently goes under the rubric of "state estimation" in power systems, namely the estimation of static power flow variables (bus angles and voltages) from generally redundant measurements. The observer work is to be presented at the North American power symposium in October 2002.

In other work, Professors Verghese and Lesieutre, with their doctoral student Sandip Roy and master's student Carlos Gomez, have been extending the scope and application of the "influence model" for networked Markov chains. This rich yet tractable model was recently introduced in the doctoral thesis of Chalee Asavathiratham (done in LEES under Professor Verghese) as an abstract representation of networks whose nodes can be in one of several states, for example, "Normal" or "Alert" or "Failed." A paper on this material appeared in the *IEEE Control Systems Magazine* in December 2001, in an issue devoted to complex systems. The paper presents an interesting example to suggest that as the nodes in a network become more reliable, and assuming local repair resources are commensurately reduced, one can arrive at a network that displays only small local failures or massive failures of the entire network, but nothing in between.

Relatives of the influence model have been developed for stochastic flow networks, and Sandip Roy has had some success with applying these and related ideas to air traffic modeling and control, during the course of a summer internship at NASA Ames. Other work is directed at solving various estimation problems related to the influence model—for instance, inferring states at hidden nodes from observations of state sequences at certain nodes in the network. The results of this research have the potential to generalize the results that are known for "hidden Markov models," a class of models that is widely used in speech processing, bioinformatics and elsewhere.

Power Electronics and Electromechanics

Over the last two years, Professor David Perreault and graduate students Joshua Phinney and Timothy Neugebauer have been developing novel inductance cancellation techniques for power filters and filter components. These techniques have been employed in the design of discrete filters using conventional components and in the design of new integrated filter elements having extremely high performance. Factors of up to 30 improvement in filtering performance have been demonstrated this year, in both discrete filters and integrated filter elements. The work to date has resulted in a US patent filing, and licensing negotiations with a major capacitor manufacturer have commenced.

Professor Perreault and graduate student Albert Chow have focused on the development of active ripple filters that greatly reduce the size of filter capacitors needed in many power electronic systems. Previously, they developed a high performance feedforward/feedback ripple filtering technique that is well suited to aerospace applications, where capacitor type and size is a critical consideration. In the past year they have developed a feedback ripple filtering technique suitable for a broad range of motor drive applications. This approach has been experimentally verified in an automotive motor drive filter, where significant cost improvements have been demonstrated as compared to a production filter design.

Professor Leeb and his students are developing a tunable vibration damper that utilizes a thermothickening gel material to reduce vibrations over a user-specified frequency range. Such a damper could solve the problem of damping vibrations in structures that encounter disturbances over a wide frequency range, automobiles for instance. The tunable gel damper is based on the idea that a variable viscosity material can be used to alter the moment of inertia associated with a rotating auxiliary mass. The thermothickening gel consists of a crosslinked network of polymers suspended in a solvent and exhibits large reversible changes in volume when thermally stimulated. Below a certain temperature threshold the polymer network is "swollen," effectively trapping the solvent within the polymer matrix. The resulting gel mixture has a considerably higher viscosity and approximates a solid mass. Above the temperature threshold, the gel undergoes a sharp decrease in volume as the polymer network "shrinks," thereby releasing the solvent and decreasing the overall viscosity of the gel mixture. This reduction in viscosity translates into an effective reduction in the moment of inertia thereby increasing the damper's resonant frequency. Structuring the damper by linking gel compartments whose transitions can be individually controlled permits control of the damping frequency.

Thermal activation of each gel-filled compartment is accomplished using a noncontact induction heating method. In order to distinguish between chambers, each compartment contains an induction target that has been designed to exhibit preferential heating at a unique frequency. This is achieved by infusing the gel with powders of metal alloys having varying conductivities. In addition to these magnetically linear alloys, the possibility of making custom powdered targets comprised of both ferrous metals and controlled amounts of resistive (but magnetically linear) materials is also being explored. A novel multilevel inverter circuit has been designed to efficiently induction heat any combinations of gel compartments by generating a sum of sinewaves signal for each frequency needed.

Micro-Electromechanical Systems

Professor Lang and graduate student Hur Koser, in collaboration with Professor Mark Allen and his students at the Georgia Institute of Technology, have completed

testing the micro-scale magnetic induction motors whose fabrication was first reported last year. The torque produced by these first-generation motors is already comparable to that which has been produced by some of the best micro-scale electric induction motors. The measured torque has also been compared to the theoretical torque predicted by a numerical model that accounts for the presence of eddy currents and saturation throughout the solid-core motors. The match between experiment and theory was excellent, and so the numerical model was used to design laminated-core motors that should perform better still. These second-generation motors have now been fabricated, and testing will begin shortly.

Dr. Carol Livermore, Dr. Stephen Umans, and Professor Jeffrey Lang, in collaboration with the many other students, staff and faculty, both on campus and at the MIT Lincoln Laboratory, who participate in the MIT Micro Gas Turbine Engine Project, have recently demonstrated the operation of a micro-scale electric induction motor that produces a 40-fold improvement in motoring torque and power in comparison to all earlier micro-scale electric motors. This performance is consistent with theoretical predictions, and those predictions indicate that much higher torques and powers can yet be achieved. Following this analysis, a new generation of motors has been designed, and those motors are currently under fabrication.

Graduate students Jian Li and Jin Qiu, and Professor Lang, in collaboration with Professor Alex Slocum of Mechanical Engineering, have recently demonstrated the design, fabrication and operation of a new electrically actuated, mechanically bistable micro-scale relay. The actuation mechanism is particularly successful in that it permits the low-voltage actuation of a relay having a relatively large contact force and stroke. They are currently working to develop this relay for use in low-voltage residential and commercial applications.

Professor Markus Zahn has developed an extensive theory and completed measurements as part of an NSF-sponsored research program to develop magnetic field–based MEMS and microfluidic technologies using sub-micron size magnetic particles in a carrier fluid. Research has resulted for the first time in a "negative" viscosity measurement in a ferrofluid stressed by a rotating magnetic field. Such "negative" viscosity effects have been paradoxical and active research areas for electrohydrodynamic and ferrohydrodynamic researchers because these effects seem to violate the second law of thermodynamics. However, research has shown no violation, but rather that the decrease and sign reversal in effective magnetoviscosity is due to magnetic body torques as the magnetization and magnetic field are not collinear in alternating magnetic fields. This effect can have many useful applications in magnetic field driven micro-fluidics sensors and actuator devices.

Personnel

Professor Zahn concluded service as a member of the National Academies Naval Studies Board Committee for Mine Warfare Assessment, Professor Leeb became a senior member of the IEEE this year, and Mr. Wayne Hagman, a staff engineer in LEES for many years, has left MIT for a position at NStar.

Honors and Awards

Administrative secretary Vivian Mizuno received a School of Engineering Infinite Mile Award for her dedicated and generous service to LEES, especially its students.

Professor Perreault has received a US Office of Naval Research Young Investigator Award.

Professor James Kirtley received the IEEE's 2002 Nikola Tesla Award.

John G. Kassakian
Director
Professor of Electromagnetic and Electronic Systems

More information about the Laboratory for Electromagnetic and Electronic Systems can be found online at http://web.mit.edu/lees-lab/www/.

Laboratory for Information and Decision Systems

The Laboratory for Information and Decision Systems (LIDS) is an interdepartmental laboratory for research and education in systems, communication, and control. It is staffed by faculty members, research scientists, postdoctoral fellows and graduate students drawn principally from the Department of Electrical Engineering and Computer Science, as well as the Department of Aeronautics and Astronautics, the Department of Mechanical Engineering, and the Sloan School of Management. Undergraduate students participate in the research program of the laboratory through the Undergraduate Research Opportunities Program. Every year, many research scientists from various parts of the world visit the laboratory to participate in its research programs.

The research goal of the laboratory is to advance the fields of systems, communication, control and signal processing. In doing this, it explicitly recognizes the interdependence of these fields and the fundamental role that mathematics, computers, and computation play in this research.

Specifically, the work conducted at LIDS falls into these areas:

- Communications, networks, and systems—includes fundamental work on data networks, information theory, and communication theory.
- Systems research—includes satellite communication, wireless communication, optical communication, and networks.
- Estimation and signal processing—includes work on multi-resolution statistical signal processing, robust estimation in the presence of non-normal noise, and the architecting and analysis of large-scale systems such as sensor networks.
- Control—ranges from theoretical issues such as robustness, aggregation, and adaptive control to the construction of a computer-aided design environment for the control of unmanned air vehicles; the use of neural networks for approximating optimal controller designs and system identification; and the study of natural neuro-control systems.
- Algorithms—includes analytical and computational methods for solving broad classes of optimization problems arising in engineering and operations research. These methods are used for applications in communication networks, control theory, power systems, computer-aided manufacturing and neuro-dynamic programming, as well as resource allocation and scheduling under uncertainty.
- Research on perceptual systems and machine learning—includes the problems of speaker-independent speech recognition and on- and off-line handwritten character recognition.

As an interdepartmental laboratory, LIDS reports to the dean of the School of Engineering, Thomas L. Magnanti. The director of LIDS is Professor Vincent W. S. Chan.

Twenty faculty members, several research staff, and approximately 100 graduate students are presently associated with the laboratory. Undergraduate students also participate in research and thesis activities. A number of postdoctoral and visiting appointments are made annually.

Financial support is provided by the Air Force Office of Scientific Research; the Army Research Office; the Cambridge University-MIT Alliance; the Defense Advanced Research Projects Agency (DARPA); Draper Laboratory; HP; Intel; Lucent Bell Laboratories; Merrill Lynch; Pierce, Fenner, and Smith, Inc.; the Multiple University Research Initiative Program (MURI); the National Aeronautics and Space Administration (NASA); the National Science Foundation; the National Reconnaissance Office; the Office of Naval Research; Tellabs, Inc.; the Ford Motor Company; and the Walsin-Lihwa Corporation.

The current research activities of the laboratory cover a wide range of theoretical and applied areas in systems, communications, control, and signal processing.

Communications

Data Communication Networks

The major objective of this work is to develop the scientific base needed to design data communication networks that are efficient, robust, and architecturally clean. Wide-area and local-area networks, high-speed and low-speed networks, and point-to-point and broadcast communication channels are of concern. Some topics of current interest are power control, the capacity of wireless channels with parallel relays, splitting and successive decoding for wireless networks, media access control protocols, routing in wireless and satellite networks, quality of service control, diverse traffic mixes, failure recovery, topological design, and the use of pricing as a mechanism for efficient resource allocation. Professors Dimitri P. Bertsekas, Vincent Chan, Robert G. Gallager, Muriel Medard, Eytan Modiano, Vahid Tarokh and John Tsitsiklis, and Drs. Jinane Abounadi, John Chapin, Steven G. Finn, Alan Kirby, Charles Rohr, Milica Stojanovic and Peter Young, and their students are conducting this research.

Optical Networks

Professors Chan, Gallager, and Modiano continue to work on the next-generation internet program funded by DARPA. The focus of the program is to design and prototype the next-generation local and metropolitan area access network (MAN) with an increase in data rate of up to four orders of magnitude, but at the same time to decrease the cost of delivery per bit by approximately the same amount.

The network will use multiple wavelengths (colors) to increase capacity and optical devices for routing and switching. New results on the use of mesh topology for MANs indicate that the cost structure of MANs is heavily dependent on the optical cross-connect technology at the switching nodes. Efficient topologies that nearly achieve fundamental bounds on performance are found, and these architectures are very different from previously used and accepted architectures. One interesting architectural feature of the network will be an option for the user of the network to set up direct, end-to-end optical flows for future applications with very large transactions (gigabytes and beyond). The architecture design was successfully completed, and a test network is deployed in eastern Massachusetts with a 10 Gbps access rate for users and well over a Tbps capacity. Direct user-to-user optical flow switching was demonstrated from Boston to Washington, DC. This new communication service type had been the focus of a number of press releases and interviews by the IEEE, Optical Society of America, and trade magazines. We have also connected this test network to others around the country to form SUPERNET, a prototype for the Next Generation Internet. Because of the interdisciplinary nature of the research, LIDS is able to partner with members of the Laboratory for Computer Science (Dr. David Clark), Lincoln Laboratory, AT&T, Cabletron, JDS Fitel, and Nortel.

Professor Modiano continues to work on an NSF grant to study mechanisms for providing optical bypass in the Next Generation Internet. The goal of the research is to use wavelength division multiplexing technology together with novel algorithms to reduce the size, cost and complexity of electronic switches and routers in the network, leading to a dramatic increase in the traffic capacity that can be supported by the NGI. New collaborations with Lucent Bell Labs have also taken place.

Professor Medard is working on issues of reliability and robustness of backbone and access networks. Her first project is in the area of probabilistic analysis of optical network robustness as part of an AFOSR University Research Initiative with Stanford University, University of Illinois, and Caltech. The work in this area considers robustness and security of all large network systems, such as backbone communication networks and power grids. Other MIT researchers on this URI project are Professors George Verghese and Bernard Lesieutre.

Professor Medard is also working on reliability of access networks. She is the MIT member of a recent NSF Information Technology Research with the University of Illinois in the area of robust optical local and metropolitan area networks. In particular, this project considers the use of course unit of measure and limited signal-to-noise ratios in architecting robust networks.

A new program sponsored by DARPA on ultra-high-reliability and performance, all-optical, local and metro area networks has been initiated by Professors Chan and Modiano. The objective of this research is to use optical network technology to build a highly reliable network that services high-end applications such as aircraft control and coherent collaborative sensing. It is the expectation of the sponsor that MIT will provide architecture lead and guidance for industry contractors.

Free-Space Optical Communications

Under DARPA sponsorship, Professors Chan and Shapiro and Dr. Franco Wong have undertaken an ambitious new development of high-rate and high-performance free-space optical communication systems and networks. This research, a joint venture between LIDS and the Research Laboratory of Electronics, explores diversity transmitter and receiver techniques to mitigate power fading due to atmospheric turbulence. In recent theoretical work, tight bounds on the channel capacity of shot-noise limited, multiple-input, multiple-output, direct-detection communications have been derived. Error probabilities for direct-detection diversity receivers that use optical pre-amplifiers have been obtained. In addition, this research group is optimizing higher-layer network protocols to adapt to the channel conditions to yield higher-network throughputs and faster response time. Substantial gains (>10dB) have been indicated via analysis. An experimental demonstration of such designs is underway in an open-air range between buildings at MIT.

Satellite Communications and Networking

The overall goal of this research addresses architecture designs for efficient data communications over low-earth orbiting satellites and other more generalized satellite systems, especially when they are interconnected with terrestrial fiber and wireless systems to form a heterogeneous global internet. There are three main components to this research:

- Adaptive power and rate control techniques for satellite communication systems over time-varying satellite channels to achieve greatly improved (an order of magnitude or more) data throughputs
- Efficient routing algorithms over a time-varying integrated and heterogeneous global network for maximum resource utilization, especially the space segments
- Efficient congestion control algorithms at the transport and network layers for an integrated satellite/terrestrial network

Professors Chan, Modiano, and Tsitsiklis, doctors Stojanovic, Finn, and Rohr, and their students are conducting this research.

During the past year, the researchers in this group have provided a power control policy that is optimized according to an outage probability requirement. They have also developed a modulation selection rule designed to satisfy an outage probability requirement for a given bit error rate. They have addressed the issue of multi-beam power allocation based on traffic demands over satellite downlinks with several types of antenna schemes. Their analysis shows that the use of the parallel multi-beam scheme with optimized power splits can achieve a substantial power gain and reasonable proportional fairness. On energy-efficient routing for satellite networks, the group has studied the problem of finding an optimal policy that maximizes expected reward by deciding how much of the demand to service at a given time. This problem is modeled using a dynamic programming formulation that, results show, could produce a significantly higher expected revenue than a simple greedy algorithm.

On congestion control for hybrid networks, the group explores the interaction between the protocols at different layers. They have developed models that could be used to analyze the performance of the Transport Layer Protocol (TCP) in the presence of a lower-layer ARQ protocol and have designed an intelligent lower-layer ARQ scheme that will substantially improve the TCP's overall throughput. They have examined the optimal spare capacity replacement problem based on mesh-torus topology and have derived algorithms for routing and failure recovery that meet the lower bound on capacity requirements.

In the study on satellite system design, and specifically on capacity dimensioning and routing for hybrid satellite and terrestrial networks, the group has formulated satellite-link dimensioning and routing as a two-stage stochastic programming problem and has solved for the optimal link capacity. This will minimize the sum of satellite network investment cost for different link-cost to user-entry-rejection-cost ratios.

In addition, Professor Modiano has initiated a research program with NASA exploring interactions in space networks between protocols at different layers of the protocol stack. A particular focus of this project will be an examination of the overall network architecture across multiple layers of the network hierarchy, seeking opportunities for cross-layer optimization. Such an approach is of particular importance for NASA's space Internet because of its heterogeneous nature. It is a goal of this project to obtain an understanding of the interactions between network layers so that overall, end-to-end performance can be significantly improved.

Space Relay Networks

Professors Chan, Gallager, Modiano, and Medard, and Drs. Chapin, Finn, Rohrs, and Young, and their students continue the study on the preferred constellation topology of the space backbone. Based on the analysis of cost vs. complexity of each constellation for the LEO, MEO, and GEO configurations, these researchers showed that a GEO backbone consisting of three satellites has cost-versus-complexity characteristics superior to other constellations and should be the choice for a space-borne data backbone network.

The group has begun to look at the architecture of a networked processing system in space and the associated problem of task scheduling. They decouple the processing units from the traditionally designed mission satellites, which allows processing resources to be shared across network users. This architectural concept alleviates the need for high data-rate downlinks and thus is much more cost-effective than a traditionally designed system. One aspect of using commercially available processors with minimal radiation shielding is the need to frequently replenish the processing resources approximately every one to two years. These frequent upgrades to the system ensure that the latest processor technology and software are used in space, thereby solving the present-day problem of performance-challenged, 10- to 20-year-old, space-qualified processors currently used in space.

The researchers have also continued the study of optimum scheduling algorithms for multiple-beam systems, coupled with efficient power management of space-borne, multiple-beam transmitters and receivers. In particular, they have addressed the tradeoff between serving a transmission request versus saving scarce energy for the sake of future and potentially more valuable requests. They have extended this methodology to other wireless communication settings besides satellite networks.

Finally, this research group believes there will be a need to send critical and time-sensitive messages to users in the field and to data processing and storage centers with a high degree of delivery guarantees. Part of the transport can touch commercial and defense networks that are not robust to natural breakage or attacks. Thus, the group has proposed a technique to send critical messages over unreliable networks via spatial diversity coding.

Professor Medard is working in the area of capacity and stability of coded, packetized, multiple-access channels with students at MIT and with Professor Steven Meyer of the University of Illinois at Urbana-Champaign and Professor Andrea Goldsmith of Stanford University. In particular, this research establishes the capacity of such channels and examines trade-offs between energy and delay. This research allows the uncoordinated access in satellite networks of multiple users without requiring total performance in the event of a packet collision. Professor Medard is also developing with students a system emulator using code-division multiple-access standards as a practical implementation of such coded, multiple-access channels.

Communication Under Channel Uncertainty

Professor Medard has been investigating several issues in the area of wireless communications over uncertain channels. In collaboration with Professor R. Srikant at the University of Illinois at Urbana-Champaign, she has investigated the effect of unequal channel knowledge at the sender and receiver. In particular, the researchers have developed performance bounds to assess the effectiveness of applying techniques designed for certain idealized channel models to other channels with more detailed models. In collaboration with Professor Goldsmith of Stanford, Professor Medard has investigated the capacity of time-varying channels with sender- and receiver-side information, in particular for channels with perfect side information but significant inter-symbol interference, for which no capacity formulas existed. In collaboration with Professor Madhow of the University of California, Santa Barbara and Dr. Ibrahim Abou-Faycal, she is working on the use of an adaptive modulator without feedback in which the sender adapts to the quality of the receiving channel measurement as well as the channel strength. This technique increases capacity by up to 30 percent without additional energy and without requiring real-time computation.

Codes on Graphs and Iterative Decoding

Professor G. David Forney, Jr., continues his research into codes on graphs and iterative decoding algorithms. He is preparing a paper on constraint complexity, which in some respects is more basic than state complexity, the focus of most prior literature.

Coding and Statistical Physics

Professor Forney continued to investigate connections between coding and statistical physics in collaboration with A. Barg (Lucent Bell Laboratories), M. Chiang (Stanford University), A. Montanari (of Paris, visiting professor Mitter at MIT) and J. Yedidia (Mitsubishi Research Labs, Cambridge). A paper with Barg on minimum distances and error exponents of codes for the binary symmetric channel using a large-deviation-theoretic approach has been accepted for the *IEEE Transactions on Information Theory*. With Montanari, this approach has been extended to general discrete memoryless channels.

Research on turbo coding, decoding of low-density parity check codes, and statistical mechanics of disordered systems has shown that there are deep connections between those subjects. Professor Mitter, in collaboration with Dr. Nigel Newton, has been conducting research on various aspects of these problems.

Professor Medard, in collaboration with Professor Ralf Koetter of the University of Illinois at Urbana-Champaign, is working on an algebraic description of codes on graphs for data transmission over networks. All routing over a network can be described as a code over that network. Moreover, network capacity in error-free networking can be significantly enhanced through the use of codes over these networks. The research by Professors Koetter and Medard has developed a powerful new construct which, when extended, not only provides all the results previously obtained by graph theoretic methods, but also gives necessary and sufficient conditions for any set of connections to be feasible over a graph where we code. This research is also being extended to robustness when link nodes are permanently removed and to the fundamental requirements of a network whose management system can recover from non-intermittent failures.

Quantum Information Theory

Yonina Eldar (Digital Signal Processing Group), working with Professor Forney, has shown that the "square-root" measurement of quantum detection theory is actually a "least-squares" measurement, from which many of its properties follow. She has also shown that there is an intimate correspondence between such measurements and the "tight frames" of wavelet and signal representation theory, which allows various quantum mechanical results to be transported to frame theory. Recent results relate to geometrically uniform measurements and frames.

Wireless Communications

Professor Tarokh, together with several students, has ongoing projects in various fields, including mobile communications, switching, data networks, data security, applications of information theory to very-large-scale integration, and free-space optical communications. Specific research includes: design of multiple-antenna communications systems; peak-to-average power reduction in wireless optical frequency division multiplexing; capacity achieving codes for wireless communications; distributed source coding; tracking fluid policies for crossbar switches; scheduling algorithms for input queued switches; coding for reduction of energy consumption and timing in buses; space-time coding for free-space optical communications; hyper-elliptic curves cryptography and measurement of multi-input multi-output wireless channels in collaboration with Lincoln Laboratories; and measurement of an ultra-wide-band (UWB) channel in collaboration with AT&T Labs. The models Professor Tarokh developed from UWB measurements are now being adapted by FCC 15.3 as standard models for future system development and comparison of UWB systems.

Collaboration with Tellabs and Draper Laboratory

The Laboratory for Information and Decision Systems; Tellabs Operations, Inc., a telecommunications equipment manufacturer; and Draper Laboratory are developing a novel approach to collaborative research. In this approach, LIDS, Tellabs, and Draper Lab integrate industrial research interests within MIT's research and educational environment. The key difference between this new model

of collaboration and traditional approaches is the focus on human resources as the primary enabler. Toward this end, LIDS provides Tellabs and Draper Lab with access to faculty, students, visitors, facilities, and infrastructure support, while Tellabs dedicates resident corporate research positions to the effort, assuming responsibility both for co-advising student research and for technology transfer as an internal corporate process. LIDS benefits from the persistent presence of industrial researchers, and our partners benefit from the leveraging of LIDS's staff.

Systems, Detection, Estimation and Optimization

Stochastic Systems Group

The Stochastic Systems Group (SSG) is led by Professor Alan S. Willsky and currently includes one research scientist, Dr. John Fisher (joint appointment with the AI Lab); one postdoctoral researcher, Dr. Mujdat Cetin; one administrative assistant, Taylore Kelly; nine graduate students and one UROP student. The web site for this group at http://ssg.mit.edu/ describes its activities, mission, current and recent research projects, and theses and publications.

Professor Willsky has been invited to write a tutorial/survey paper for the *Proceedings of the IEEE* on the extensive research in multiresolution statistical modeling and processing, in which his group has had a leading role. He has continued as an active participant on the US Air Force scientific advisory board and has also taken on a role as an advisor to the National Reconnaissance Office.

Professor Willsky has been involved in three large programs: He was the MIT principal investigator of a large and recently completed MURI program (involving seven universities) on automatic target recognition. This program has been cited twice by the Air Force for excellence. He has taken over the role as principal investigator of the SensorWeb MURI program on data fusion of large arrays of microsensors, a program involving researchers at LIDS, the Artificial Intelligence Laboratory, Princeton University, and the University of Illinois. He is one of the principal investigators of a large NSF-ITR award on innovative methods for large-scale geophysical data assimilation. This is an interdisciplinary program involving faculty from LIDS, the Research Laboratory of Electronics, Earth and Planetary Sciences, and Civil and Environmental Engineering.

The SSG has been actively involved in numerous collaborations extending beyond the boundaries of LIDS. It has had substantial interactions with the AI Lab, including the computer vision and machine learning groups (professors Grimson, Freeman, and Jaakkola) and the AI Smart Room (Professor Darrell). It has growing interactions with LCS in computer graphics (Professor McMillan) and graph theory (Professor Karger). The group has had (and through the NSF-ITR program mentioned above will continue to have) substantial collaborations in data assimilation with faculty in Civil and Environmental Engineering (McLaughlin and Entekhabi) and Earth, Atmospheric and Planetary Sciences (EAPS) (Wunsch, Rizzoli, Emanuel, Hanson). It recently initiated explorations, together with Professor Michael Perrott of Microsystems Technology Laboratories, on use of its image magnification algorithms for magnification of computer-generated art.

The group also has a continuing collaboration with researchers at Brigham and Women's Hospital in the area of medical image analysis, particularly in the area of advanced algorithms for prostate image segmentation.

The research in the SSG currently focuses on three areas:

—The group's research in multiresolution algorithms has resulted in powerful algorithms that are finding significant and growing use in a wide variety of disciplines, ranging from geophysical data assimilation to computer vision and image processing. In the past few years, the focus of this work has expanded to a broader class of so-called graphical models. The researchers have developed some powerful new algorithms that will have impact not only on fields mentioned previously but also in the very active fields of machine learning and coding theory. One recent graduate, Dr. Martin Wainwright, has been cited for his work in this area.

—Work on robust curve evolution methods is central to the SSG's collaboration with Brigham and Women's Hospital and also to its work on computer art magnification. Recent graduate Dr. Andy Tsai has been recognized for his research in this area. In addition, through the recent NSF-ITR award, the group is exploring significant extensions of its methods to deal with space-time tracking of large coherent structures (e.g., weather fronts) in geophysical data. This work is carried out in collaboration with researchers in EAPS.

—The SSG is also actively involved in machine learning and robust statistical methods for the fusion of heterogeneous sensors. This work, which includes work on the SensorWeb program and also the collaboration with the AI Smart Room project, involves developing robust and efficient algorithms for fusing data from distributed ad hoc sensor arrays in the presence of unknown or uncertain relationships among the sensors (e.g., in fusing video and audio, or in fusing audio sensors in complex reverberant environments or in the presence of uncertainties in the locations of the sensors).

Neurobiological Modeling

Professors Munther Dahleh and Steve Massaquoi are interested in two problems. The first is the development of a hierarchical model of the interaction between the cerebrum

and cerebellum that is anatomically justified and that can explain multivariable dynamic stabilization and control. The second problem is deriving a multi-scale, multi-resolution model that explains electroencephalography (EEG) data, with specific interests in motor control, anesthesia and evaluation of cortical function and dysfunction. These projects are in collaboration with various laboratories/ departments at MIT as well as the Massachusetts General Hospital (MGH). The third is the development of a circuit model of basal ganglia that describes the basal ganglia's function in both low-level control of movement speed as well as in motor programming.

Substantial progress was made in the area of developing reduced-order models for the cerebellum and its interactions with the cerebrum and spinal cord. Progress has been made in utilizing these models for interpreting speed and directional information present in actual cerebellar data. According to collaborator Dr. Timothy Ebner of the University of Minnesota, a cerebrocerebellar control model now appears to explain observed input-output behavior as well as approximate many neural signals observed in vivo.

In a parallel effort concerning modeling EEG data, Professors Dahleh and Massaquoi have developed a basic circuit that constitutes a fundamental cerebral function module. The circuit describes local and global interconnections between the different layers and has been successful in simulating several important states of the brain. This development is quite unique, and the professors expect several interesting fundamental models to emerge. The work is done in collaboration with Professor Dahleh's student Fadi Karame and Dr. Emery Brown (MGH). The objective of this research is to utilize such a model to classify different sleep stages while applying anesthesia, detect structural and functional aberrations in the cerebrum, and ultimately gain insight into the mechanisms of cognition.

Progress has also been made in developing a unified model of basal ganglia function that interprets the structure as implementing a logical operator that enables programmed control of behavior ranging from cruising movements to cooperative interaction with the environment.

Algorithms

This project focuses on analytical and computational methods for solving broad classes of optimization problems arising in engineering and operations research, as well as for applications in communication networks, control theory, power systems, computer-aided manufacturing and other areas. Currently, in addition to traditional subjects in nonlinear and dynamic programming, there is an emphasis on the solution of large-scale problems involving network flows, as well as on the application of decomposition methods. Professors Dimitri Bertsekas and John Tsitsiklis and their students perform this work.

Neurodynamic Programming

Problems of sequential decision-making under uncertainty are all-pervasive; for example, they arise in the contexts of communication networks, manufacturing systems and logistics and in the control of nonlinear dynamical systems. In theory, such problems can be addressed using dynamic programming techniques. In practice, however, only problems with moderately sized state space can be handled.

This research effort entails application of neural networks and other approximation and interpolation methodologies to overcome the curse of dimensionality of real-world stochastic control problems. The objectives driving this research are twofold. First, to develop the theoretical foundations and improve the understanding of such methods using a combination of tools from approximation theory, dynamic programming and stochastic algorithms; and second, to use these methods for solving some large-scale problems of practical interest. Application areas currently being investigated include problems in logistics (resource scheduling and assignment), finance (pricing of high-dimensional derivative instruments, dynamic portfolio management in the presence of risk constraints), supply chain management, and communications (dynamic channel allocation). Professors Bertsekas and Tsitsiklis and their students perform this work.

Fundamental Issues in Optimization

This research focuses on fundamental analytical and computational issues in (deterministic) optimization that are connected through the themes of convexity, Lagrange multipliers, and duality. The aim is to develop the core analytical issues of continuous optimization, duality, and saddle point theory using a handful of unifying principles that can be easily visualized and readily understood. As part of this effort, a new approach to Lagrange multiplier theory is being explored, based on a set of enhanced Fritz-John conditions and the notion of constraint pseudonormality. Professor Bertsekas and his students perform this work.

Supply Chain Management

Professor Tsitsiklis and his students have considered uncapacitated serial inventory systems ("supply chains") with Markov-modulated demand and Markov-modulated, stochastic, but non-overtaking leadtimes. We developed a novel approach, based on decomposition into a collection of single-item, single-customer problems that are essentially decoupled. We have shown that this technique results in a very simple derivation of existing results (optimality of state-dependent echelon basestock policies), new and efficient computational algorithms, and several new results. We expect this general approach to lead to efficient exact or approximate solutions to other related problems, thus advancing the state of the art. Student Alp Muharremoglu's work in this area has been cited for excellence.

Perceptual Systems

Professor Sanjoy Mitter and his collaborators have been working on various aspects of perception and recognition. Perception and recognition involve recovering useful information about the environment from sensed data and prior knowledge about the real world and the sensors. Artificial systems designed to carry out this task are much inferior to biological systems, largely due to the size and intricacy of the knowledge required to carry out reliable inference in unrestricted and uncertain domains. For instance, in visual perception, several factors contribute to render the problem difficult—clutter, occlusion and variability of the objects in the scene. The basic engineering principle of decomposing a complex task into simpler and independent tasks is difficult to apply to perception and recognition due to the extremely complicated and yet unknown patterns of interdependency among the many "acts of perception" involved. For example, the recognition of an occluded chair in a cluttered office environment is highly dependent on the interpretation of its subparts, the other objects near it and the overall scene of which it is part. What are the components involved in perception and recognition? Into what architecture should these components be organized? How does one minimize the interdependence of these components? How should uncertainty be represented? How does one acquire and represent the knowledge about the real world and the sensors? Several projects are being undertaken to find answers to these questions.

An approach to recognition involving both top-down and bottom-up processing of images is being developed in the doctoral thesis of Maurice Chu.

A hierarchical approach to contour estimation has been developed by adding more general models of object contours to the hierarchy. The current edge model in development includes illusory contours and curve singularities (corners and junctions) but is limited to convex closed contours.

A new computational theory for the recognition of occluded deformable templates in a cluttered scene has led to efficient algorithms with guaranteed performance in terms of localization errors and time complexity. Currently, this approach has been applied to features consisting of points in the plane and to affine deformations. Future work will seek to generalize these assumptions.

Early recognition of moving ground targets from an approaching platform is an important task for the military. To enhance the performance of existing systems, it is necessary to combine information from multiple frames, which contain the target at different resolutions. This project is still at an early stage, and initial efforts have focused on the incorporation of continuity and smoothness constraints of the relative motion of the target with respect to the camera by means of a geodesic approach.

Control in Presence of Communications Constraints

Professor Mitter, in collaboration with Professor Vivek Borkar (Tata Institute of Fundamental Research, India) and several graduate students, has been working on fundamental issues of control in the presence of communication constraints. The goal of this research is to understand the interaction between information and control in the presence of uncertainty. Development of real-time information theory forms an essential part of this research topic. The recently completed theses of Drs. Anant Sahai and Sekhar Tatikonda demonstrate significant progress in this subject.

Language Modeling

Professor Robert C. Berwick and his students have implemented several novel models for learning based on theoretically minimal amounts of information. Children can learn the meaning of a novel word with as little as one example—often called "one-shot learning" or "fast-mapping." Professor Berwick's group has implemented this in a Bayesian framework, integrating both syntactic evidence (what other words appear in the sentence) and scene evidence (how the learner perceives or conceives the world) to acquire word-concept mappings. These models demonstrate that given a hypothesis space of possible word meanings and likelihood models of how syntactic and scene evidence differentially support hypotheses in this space, standard Bayesian analyses predict a posterior probability distribution over possible concepts.

In contrast to constraint-satisfaction-based models (which do not rule out overly general word meanings), connectionist models (which require hundreds of "epochs" and cannot model one-shot learning), or models which use only one type of evidence (typically just syntactic frames), this Bayesian approach explicitly factors prior knowledge, integrates disparate evidence, handles noise, and models a key competence of human language learners: generalization from one example.

These results were reported in the major conferences of the computational linguistics and cognitive science community during the past year.

To test the adequacy of their model, the group is developing a TheoryNet architecture that demonstrates how large numbers of English verbs may map onto particular combinations of causal schemas and that shows how each of the assigned schemas predict the range of syntactic frames in which these verbs may appear. When implemented later this year, this will be able to replace the WordNet system that is now the most widely used computational dictionary on the web. Professor Berwick and his students are currently testing this model with experimental subjects as well—both adults and children. If correct, such a model would afford tremendous improvement over brute-force "statistical" methods currently used.

Electric Power Systems and Critical Network Infrastructures

Dr. Marija Ilic, together with her graduate students, postdoctoral associates and international visitors, continues to work on new concepts for planning and operating electric power systems under restructuring. As it is well known from the recent California energy crisis, the competitive electric power industry is not evolving as hoped. Prices are high and changeable, supply is sometimes inadequate, and there are no true incentives in place for most effective technology penetration. The research group led by Dr. Ilic has performed a series of studies that should help these issues. The entire January/March 2001 MIT E-Lab Newsletter covers the contributions of her group in this area and the relevance of that work to the industry. More information about this research can be found on the web at http://web.mit.edu/energylab/www/e-lab/jan-mar01/jan-mar01.html/.

It is becoming increasingly clear that the hardest questions as the power industry transforms itself concern complex system interactions in which technical, economic and regulatory signals interact under various uncertainties and at non-uniform rates. Recognizing these complex interactions, the group is at present concentrating its efforts on engineering design of energy markets.

More generally, graduate level courses offered by Dr. Ilic, as well as the overall research direction, recognize the need for modeling, analysis and design that begin to relate engineering processes to economic and regulatory processes. For example, Dr. Ilic just co-authored a book with her former doctoral student Dr. Petter Skantze entitled *Valuation, Hedging and Speculation in Competitive Electricity Markets: A Fundamental Approach.* The book was published by Kluwer Academic Publishers in August 2001. The authors reevaluate a number of key premises underlying modern finance theory, including the arbitrage pricing theory in markets for near non-storable commodities, such as electricity.

Most recently, Dr. Ilic has participated in several workshops concerning security of the national infrastructures, including the electric power grid. She is beginning to develop a control engineering approach to modeling and decision-making to manage the electric power grid securely. In preparation for this major undertaking, she taught a spring 2002 course on large-scale dynamic systems, with an emphasis on identifying theoretical challenges when applying the existing knowledge to modeling and control of complex network infrastructures.

Automotive Safety

In 2002, LIDS became involved with developing safety-enhancement mechanisms for the automotive industry, under Ford sponsorship. Under the Ford-MIT alliance, Professor Eric Feron has assumed the responsibility of developing and managing the safety research program of the alliance, along with investigators in the AI Lab, the Center for Transportation and Logistics, the Department of Aeronautics and Astronautics, and LIDS. His research group focuses on the development of collision alerting systems for operation on-board a single vehicle or in a networked fashion.

Control

Multivariable and Robust Control

The systematic design of multiple-input, multiple-output systems, using a unified time-domain and frequency-domain framework to meet accurate performance in the presence of plant and input uncertainty, is an extremely active research area in LIDS. Various theoretical and applied studies are being carried out by Professors Munther A. Dahleh, Eric Feron (chair of the IEEE Technical Committee on Robust Control), Steve Massaquoi, Alexandre Megretski and their students.

Theoretical research deals with issues of robustness, aggregation, and adaptive control. The aim of the research is to derive a computer-aided design environment for the design of control systems, which can address general performance objectives for various classes of uncertainty. Furthermore, new results on the robustness of nonlinear feedback systems, using feedback linearization, have been obtained for unstructured uncertainty model errors.

Recent application-oriented studies include the control of large space structures, helicopters and submarine control systems; issues of integrated flight control; control of chemical processes and distillation columns; automotive control systems; and the modeling and analysis of biological control systems.

New applications for robust and programmed (finite state-based) control theory are emerging at LIDS, including the real-time, agile guidance of single and multiple unmanned aerial vehicles, as well as vehicle anti-collision problems arising in air traffic control. Some of these concepts are implemented and tested on small helicopter systems.

Professors Eric Feron and Steve Massaquoi are involved in a collaboration regarding the internal mechanisms that underlie the brain's ability to acquire programs that manage external dynamics and communication.

Evolutionary Control

Another new thrust regards the general question of how control systems might evolve over time to manage complex control problems. Professors Sanjoy Mitter, Munther Dahleh, Steve Massaquoi and Robert Berwick and postdoctoral associates Reuben Rabi and Fadi Nabib Karameh conduct this work. The hope is to understand principles common to self-optimizing control systems across multiple scales of time and space. Biology is used as

the guiding example, with analysis of systems ranging from molecular biological control of metabolism to organ system interaction to ecological regulation.

Feedback Control Using Approximate Dynamic Programming

Feedback controllers for nonlinear systems are often driven by potential (Lyapunov) functions, whereby the controller at each step steers the system in a direction of decrease of the potential function. The optimal cost-to-go function that results from dynamic programming formulations of control problems is a suitable such Lyapunov function, except that it may be difficult to compute. This research investigates whether recent approximate dynamic programming methods, that rely extensively on simulation and neural network training, can lead to a viable methodology for designing Lyapunov functions and controllers for nonlinear feedback systems. This research is carried out by professors Munther Dahleh and John Tsitsiklis and their students.

Identification and Adaptive Control

Determining the fundamental limitations and capabilities of identification and adaptive control is an active area of research carried out by professors Dahleh and Tsitsiklis and their students. This research program draws upon areas such as information-based complexity theory and computational learning theory, as well as upon the theory of robust control. One aim of this research is to develop a theory that combines both system identification and robust control within the same framework, in which a controller that meets given performance specifications can be designed based on finite noisy data. Issues studied include the representation of uncertainty in both noise and model, design of experiments, sample and computational complexity, and implementation of optimal algorithms.

Computational Complexity

Problems in systems and control theory are of varying degrees of difficulty, ranging from polynomial-time solvable to undecidable. Professor Tsitsiklis and coworkers have been using tools from theoretical computer science (theory of computation) to characterize the intrinsic difficulty of problems in stochastic optimal control, as well as various stability problems for hybrid systems, saturated linear systems and linear time-varying systems.

Control in Presence of Communications Constraints

Professor Mitter, in collaboration with Professor Vivek Borkar (Tata Institute of Fundamental Research, India), Dr. Nicola Elia and several graduate students, has been working on fundamental issues of control in the presence of communication constraints. The goal of this research is to understand the interaction between information and control in the presence of uncertainty. Development of real-time information theory forms an essential part of this research topic. The recent completed theses of doctors Anant Sahai and Sekhar Tatikonda demonstrate significant progress in this important subject.

Unmanned Air Vehicles

Professors Dahleh and Feron and their students have been working on developing control architectures for unmanned vehicles. They have derived an architecture for the autonomous controller that enables the vehicle to perform agile maneuvers. The basis for this architecture is the derivation of a robust hybrid automaton. This automaton describes a rich set of controlled trajectories that can be attained by the vehicle, as well as the control necessary to transition between these trajectories. The robustness analysis of this dynamical description gives rise to a new and exciting class of robustness analysis problems that has not been looked at in the literature.

The researchers have developed a complete simulation/animation environment, and their software (based on the above architecture) is now in use at Draper Laboratories, Barron Associates, Inc. and the Air Force research laboratory. A recent development in this problem is deriving efficient algorithms for performing real-time motion planning (contrasted from path planning, where vehicle dynamics are not taken into account) in a cluttered environment. These algorithms are based on randomization techniques performed on the manifold on which the dynamics evolve. This research entails the development of a hierarchical control system that replaces the human pilot in order to perform agile maneuvers.

In late 2001, a miniature helicopter that the researchers built performed the first-known autonomous aileron roll by a helicopter. The achievement was covered by the media worldwide, including the Associated Press, abcnews.com, *Engineering Times*, *PM-Redakteur* and *Sciences et Avenir*. Professor Feron and his students have received honors for their work in this area.

With sponsorship from the Draper Laboratory, Professor John Deyst and his students are developing new guidance and control methods for the operation of intelligent unmanned air vehicles (UAVs). This work addresses the coordinated action of groups of UAVs that operate cooperatively to accomplish complex tasks. Such coordinated action is required to accomplish tasks that are impossible or that would take excessively long periods of time for a single vehicle to complete. Significant issues being addressed are the safe and effective flight of UAVs near each other, including rendezvous and docking of one vehicle with another. This capability is of particular significance for resupply of one vehicle by another, so as to allow sustained operation near some desired location, which might be some distance from a user. Coordinated flight is also essential for integrating various kinds of information sensed by many

vehicles simultaneously. The operational needs of this class of systems pose particularly stringent requirements on various aspects of vehicle guidance and control.

Highlights

Several LIDS personnel received recognition and honors for their work over the past year.

Professor Robert Gallager won the 2002 Eduard Rhein Foundation's basic research award, Europe's biggest such award.

Professor Muriel Medard was awarded the 2002 Leon K. Kirchmayer Prize Paper Award for her paper titled "The Effect Upon Channel Capacity in Wireless Communications of Perfect and Imperfect Knowledge of the Channel." The award is presented by the IEEE Board of Directors for the most outstanding paper by an author (or authors) under 30.

A paper by Professor Eric Feron and his students titled "Design and Applications of an Avionics System for a Miniature Acrobatic Helicopter" won the best paper award at the October 2001 Digital Avionics Systems conference.

Professor Sanjoy Mitter was the plenary lecturer at "Control with Limited Information," European Control conference, Porto, Portugal, September 2001. He was the invited lecturer at "Autonomy and Adaptiveness: A Perspective on Neural Organization," IBM Technological Summit on Autonomic Computing, May 2002.

Professor Vahid Tarokh was recognized by *Technology Review* magazine as one of the top 100 inventors of the year. He also delivered the Cullimore Distinguished Lecture Series and ETRI Distinguished Lecture Series in 2001.

Professor Vincent Chan was made a fellow of the Optical Society of America in the spring. He was the William Mong distinguished lecturer at the University of Hong Kong during IAP and a distinguished lecturer at the Chinese University of Hong Kong in April. He was also the keynote speaker at the Symposium on Photonics, Networking and Computing in Durham, NC, in March. His brain child, GeoLITE—an optical space communication system—went through successful space demonstration last year and received the David Packard excellence award.

Peter Marbach, LIDS graduate and assistant professor of computer science at the University of Toronto, won the best paper award at the IEEE Infocom 2002 for his paper "Priority Service and Max-Min Fairness." Professor Medard received honorable mention at the same conference for her paper "Beyond Routing: An Algebraic Approach to Network Coding," co-authored with Ralf Koetter.

Student Alp Muharremoglu won first place in the George Nicholson Student Paper Competition (awarded by the Institute for Operations Research and the Management Sciences for the best paper in that field written by a student).

LIDS graduate and Bell Laboratories/Lucent Technologies researcher I. Emre Telatar won the prize paper award of the Information Theory Society at the 2002 IEEE International Symposium on Information Theory for his paper titled "Capacity of Multi-antenna Gaussian Channels."

Dr. Andy Tsai, a member of the Stochastic Systems Group, received the best student paper award at the 2001 Conference on Vision and Pattern Recognition (CVPR 2001).

David Tse, LIDS graduate and associate professor of electrical engineering and computer science at the University of California-Berkeley, won the 2001 IEEE Communications and Information Theory Societies' joint paper award for "Linear Multiuser Receivers: Effective Interference, Effective Bandwidth and User Capacity," co-authored with S. Hanly.

Dr. Martin Wainwright, a member of the Stochastic Systems Group, received honorable mention in the best student paper competition at NIPS (Neural Information Processing Systems) 2001.

LIDS Colloquium and Seminar

Speakers in the LIDS Colloquium and Seminar series included Dr. Michael Mitzenmacher, Harvard University; Dr. P.R. Kumar, University of Illinois; Professor Anthony Yezzi, Georgia Tech; Dr. Sumeet Sandhu, Stanford University; Professor Sergio, Princeton University; Professor Daniel A. Spielman, MIT; Dr. Daniel Chasman, Variagenics, Cambridge, Massachusetts; Professor Sean Meyan, University of Illinois at Urbana-Champaign; Dr. Ray Leopole, vice president and chief technology officer, Global Telecommunications Solutions Sector, Motorola, Inc.; Dr. Gerhard Kramer, Bell Laboratories, Lucent Technologies; Dr. Marija Ilic, MIT; Dr. Ruediger L. Urbanke, Swiss Federal Institute of Technology, Lausanne; Professor Amos Lapidoth, Swiss Federal Institute of Technology, Zurich; Professor Steven S. Lumetta, University of Illinois at Urbana-Champaign; Professor Rahul Sarpeshkar, MIT; Professor Stanley Osher, UCLA; Professor Rajeev Alur, University of Pennsylvania; Professor H. Vincent Poor, Princeton University; Professor Claire Tomlin, Stanford University; Professor Pierre Moulin, University of Illinois at Urbana-Champaign; Dr. Dennis Goeckel, University of Massachusetts; Dr. Abbas El Gamal, Stanford University; Professor Dimitri Bertsekas, MIT; Professor Abhijit Banerjee, MIT; Professor Alexandra Duel-Hallen, North Carolina State University; and Dr. Steven E. Brenner, University of California at Berkeley.

Visiting Scholars

Visitors to the Laboratory for Information and Decision Systems included Rami Abdallah, RSI, Argentina; Professor Vincent Blondell, Université de Liege, Liege, Belgium; Professor Vijay Chandru, Tata Institute, Bangalore, India; Mattia Fedrigo, Scuola Normale Superiore, Pisa, Italy; Claudio Ferrero, RSI, Argentina; Professor Ulf Jonsson, Royal Institute of Technology, Stockholm, Sweden; Professor Ralf Koetter, University of Illinois, Urbana, Illinois; Professor Mario Milanese, Politecnico di Torino, Torino, Italy; Dr. Andrea Montanari, Ecole Normale Superieure, Paris, France; Dr. Nigel Newton, University of Essex, Colchester, UK; Linus Nilsson, Lund Technical University, Sweden; Professor Anders Rantzer, Lund Institute, Sweden; Per Rehnquist, KTH, Stockholm, Sweden; and Professor Nicholas Sourlas, Ecole Normale Superieure, Paris, France.

Vincent W. S. Chan
Director
Joan and Irwin M. Jacobs Professor of Electrical Engineering and Aeronautics and Astronautics

More information about the Laboratory for Information and Decision Systems can be found on the web at http://lids.mit.edu/.

Integrated Studies Program

In the final year of this freshman learning community, the Integrated Studies Program (ISP) offered a curriculum for first-year students built around the study of technologies as they are practiced in different cultures and historical periods. ISP promoted a form of education that sought to show students the connections among ideas and processes in the sciences, humanities, and social sciences. Hands-on learning complemented the theoretical work that is a typical component of most first-year coursework. ISP strove to provide students the academic and social foundation for success at MIT and beyond by creating a community devoted to team approaches to design and problem solving, inquiry, enhanced communication skills, and lifelong learning.

Program Highlights

ISP's fall and spring HASS-D subjects were team-taught by Professor Arthur Steinberg, Dr. Peter Dourmashkin, and Ms. Frederica Steinberg, with the assistance of a variety of guest lecturers and workshop facilitators. In these subjects, students explored the relationship between technologies and the cultures in which they developed. Mr. Daniel Krynytzky, a visiting architect from California, spent a month in residence at ISP to develop and teach a unit on design. Under his guidance, students studied the design and construction of MIT's Stata Center, and experimented with principles of design by building paper hats and creative models of the MIT campus. Other modules focused on food production, metalworking, clocks and clock making, bridge building, the textile industry, and the history of the automobile industry. Mr. Toby Bashaw ran a series of smithing workshops to complement a classroom unit focused on the steel industry and the history of blacksmithing.

Ms. Debbie Watson ran workshops in weaving in conjunction with the unit focused on the textile industry. Students also developed detailed business plans for textile mills.

ISP continued to focus attention on developing a strong writing curriculum under the leadership of Ms. Steinberg, with assistance from Ms. Debra Aczel. Students in the fall and spring HASS-D subjects wrote several papers of increasing length and sophistication; produced outlines, rough drafts, and abstracts; and spent considerable time working with writing graders/tutors to revise papers

ISP hosted a weekly luncheon for freshmen with speakers from MIT and the greater community to discuss their work.

Students attended lectures in math and science subjects with the rest of the freshmen class, but were able to choose ISP-sponsored recitations in some subjects. Most students enrolled in 8.01x and 8.02x, experiential physics courses.

Staff and Enrollment

After 13 years as director of ISP and 37 years at MIT, Professor Arthur Steinberg retired at the end of this academic year. As a result, the Integrated Studies Program has now become Terrascope, which will encompass the Mission 2006 program. The new program directors are Kip Hodges and Penny Chisholm.

Ms. Aczel was the program administrator. Ms. Weinrib was the administrative assistant.

ISP enrolled 34 students (22 male, 12 female) in fall and 28 students (23 male, five female) in spring.

Arthur Steinberg
Director
Professor of Anthropology

More information about the new Terrascope program can be found on the web at http://web.mit.edu/terrascope/www/.

Lemelson-MIT Program

One of America's most prolific inventors, Jerome H. Lemelson (1923–1997), and his wife Dorothy, established the Lemelson-MIT Program at MIT in 1994. The program is administered by MIT at the School of Engineering under the guidance of director Merton Flemings, Toyota professor emeritus of materials processing, and executive director Kristin Finn. The mission of the program is to raise the stature of inventors and innovators and foster invention and innovation among young people.

Each year the Lemelson-MIT Program awards a series of prizes recognizing outstanding achievement in invention and innovation. Awards include the $500,000 Lemelson-MIT Prize, the honorary Lifetime Achievement Award, the $30,000 Lemelson-MIT Student Prize, and the High School Invention Apprenticeship.

The program also sponsors ongoing public education and informational activities designed to raise awareness about the importance of invention to the American economy. These include *Inventing Modern America: From the Microwave to the Mouse*, a book profiling the life and work of 35 prominent inventors; The *Invention Dimension* web site at http://web.mit.edu/invent/, a clearinghouse for information on inventing; The *Invention Index*, an annual survey of Americans' perceptions about invention; and *Inventory*, a biannual newsletter promoting inventive creativity.

The Lemelson-MIT Program is part of the Lemelson national program in invention, innovation, and creativity, which funds initiatives at MIT, Hampshire College, the National Inventors and Innovators Alliance, the University of Nevada at Reno, and the National Museum of American History at the Smithsonian Institution.

Annual Invention Awards

The $500,000 Lemelson-MIT Prize

Presented to an outstanding living American inventor-innovator who has significantly benefited society, the Lemelson-MIT Prize is the program's most prestigious and visible vehicle for creating excitement about invention and innovation. Called "the equivalent of the Oscars for inventors" by CNN, the prize is the world's largest single award for invention and innovation.

This year's prize recipient, Dean Kamen, was announced in San Francisco on April 23rd. Kamen was recognized for a number of inventions, including a portable dialysis machine; a wearable infusion pump that revolutionized drug delivery; the Independence™ IBOT™ mobility system, a stair-climbing wheelchair; and most recently, the self-balancing Segway™ human transporter. Kamen's inspiring career has been defined by two things—an intense commitment to enhancing human capabilities through technology and innovation; and a keen desire to excite high school students about invention, science, and engineering through FIRST robotics competitions.

Over 430 representatives from industry, academia, government, and the media attended the black tie event at the San Francisco Museum of Modern Art. MIT president emeritus Paul Gray welcomed guests and Dean Thomas Magnanti presented the $500,000 prize.

The Lemelson-MIT Lifetime Achievement Award

Designed to complement the $500,000 Lemelson-MIT Prize, the Lifetime Achievement Award recognizes a distinguished American inventor/innovator for lifelong contributions to invention or invention education.

Dr. Ruth Benerito was named this year's Lifetime Achievement Award winner at the April 23rd ceremony at the San Francisco Museum of Modern Art. She was lauded for vital contributions that helped transform the textile, wood and paper industries. Her most notable achievement was the development of easy-care cotton—the precursor to "wash and wear" clothing.

The $30,000 Lemelson-MIT Student Prize

Given to an MIT student for remarkable inventiveness, the Student Prize recognizes a talented early career inventor and positive young role model. This year's recipient, Andrew Heafitz of Newton, Massachusetts, upheld the strong tradition of exceptional Student Prize winners. A 32-year-old MIT doctoral candidate in mechanical engineering, Heafitz was honored at a press conference on March 6. He won the prize for a variety of inventions, most notably his low-cost rocket engine and an aerial surveillance system designed for the US Army.

At one-tenth the cost of existing rocket engines, Heafitz's kerosene-liquid oxygen model uses a solar car motor to get it up to full speed before igniting. His experience and familiarity with solar-powered cars, which he builds and races as a hobby, prompted him to choose this type of motor as the focus of his master's thesis. Heafitz's aerial surveillance system is a soda can–sized device that transmits aerial reconnaissance pictures to a laptop computer. He is forming TacShot Inc. to produce these affordable devices.

The Lemelson-MIT High School Invention Apprenticeship

Awarded to a talented high school student inventor, the Invention Apprenticeship pairs the winning student with a professional "invention mentor" of the student's choice from a list provided by the program.

This year's Lemelson-MIT High School Invention Apprenticeship winner was Kavita Shukla, a 17-year-old senior from Ellicott City, Maryland. Kavita's latest invention is an ecologically friendly packaging for fruits and

vegetables that uses the herb fenugreek to retard spoilage. Kavita received a patent for her product this spring. She also holds a patent for Smart Lid, a lab safety device for bottles containing hazardous chemicals.

Kavita chose to work with David Payton, one of the nation's leading authorities in autonomous systems and robotics and principal scientist at HRL

Laboratories in Malibu, California. Jointly owned by the Boeing Company, General Motors, and Raytheon Company, HRL Laboratories conducts research in electronics and information sciences, creating products for space, telecommunications, defense and the automotive industry. Announced on June 4, the apprenticeship exposed Kavita to several innovative projects at HRL from June 3 to 21.

Outreach Activities and Events

Inventing Modern America, from the Microwave to the Mouse

With generous support from the Lemelson Foundation, we published *Inventing Modern America: From the Microwave to the Mouse* in time for holiday sales. Targeted for the young adult and adult audience, the book highlights American ingenuity and inventiveness through in-depth profiles of the life and work of 35 outstanding inventors. These lively, illustrated stories show American inventors to be as diverse and interesting as their inventions. The book's companion web site at http://www.inventingmodernamerica.com helps viewers explore the courage, insight, know-how, vision and perseverance of selected inventors. Two interactive games and "Facts from the Book" are fun features of this colorful and easy-to-navigate site.

We celebrated the launch of the book with a panel discussion and reception on MIT's campus on November 27. Interest in the panel discussion was strong, and we had to turn away guests from the packed 300-seat auditorium. Our all-star panel of inventors included Steve Wozniak, Robert Langer, Doug Engelbart, Ray Kurzweil, and Brian Hubert. Christopher Lydon, former NPR talk show host, orchestrated their discussion.

InvenTeam Grants

Our new grants program is designed for teams of high school students, their teacher, and a mentor from industry. The pilot phase of the program was introduced to New England secondary school science teachers on April 1, 2002, when 4,000 brochure/request for proposals were mailed out, and hundreds circulated via email. Brochures and application forms are also available online at http://web.mit.edu/invent/www/InvenTeam/.

In June, we selected 10 semi-finalists who will develop final proposals after the start of school in September. In October 2002, we will select three finalists in diverse educational settings for grants up to $10,000 each. Their charge will be to invent something relevant to a problem in their school or community, and to present a working prototype by April 2003. We look forward to showcasing their work at next year's Lemelson-MIT awards ceremony and aspire to expand the program nationally in subsequent years.

In connection with InvenTeam Grants, we are building a component to our Invention Dimension web site that will support grant recipients, provide a mechanism for regular progress reporting to our program, and a communications link among teams. A one-day introductory workshop will be held at MIT next fall for participating teams.

MIT IDEAS Competition

The Lemelson-MIT program contributed $10,000 in prize money to the new MIT IDEAS competition, the brainchild of Amy Smith, 2000 winner of the Lemelson-MIT Student Prize, and MIT's Public Service Center. MIT IDEAS competition is designed to support innovative student projects addressing community needs. LMIT's portion of the prize money was awarded for technological innovations in emerging countries. Director Merton Flemings presented two $5,000 prizes for a pair of winning projects on May 9 at the IDEAS awards ceremony on campus.

The first project was an inexpensive, portable incubator for premature infants designed to run without electricity. The second prize went to a group developing a drinking water treatment system for households in Bangladesh, West Bengal, and Nepal where arsenic and pathogens contaminate water supplies.

MIT E-Team Courses

The Lemelson-MIT Program provides a total of $110,000 in support of the following invention-related courses at MIT: 15.783J Product Design and Development, taught by Steven Eppinger; 15.399 Entrepreneurship Lab, taught by Kenneth Morse, John Preston, and Barbara Bund; and 2.009 Product Engineering Processes, taught by David Wallace.

Organizational Changes

This year responsibility for the Lemelson-MIT Program shifted from the Sloan School of Management to the School of Engineering. Formerly under the guidance of Sloan professor Lester Thurow, the program is now directed by Merton C. Flemings, Toyota professor emeritus. Kristin Finn replaced Annmarie Amparo as executive director and offices were moved from the third floor to the second floor in Building E60. Staff increased by 1 ½ employees to accommodate an increase in program activities.

Merton Flemings
Director
Toyota Professor Emeritus of Materials Processing

More information about the Lemelson-MIT Program can be found on the web at http://web.mit.edu/invent/.

Laboratory for Manufacturing and Productivity

The Laboratory for Manufacturing and Productivity (LMP) is an interdepartmental laboratory in the School of Engineering with three major goals:

- Development of the fundamental principles of manufacturing systems, processes, and machines
- Application of those principles to manufacturing enterprises
- Education of engineering leaders

With 13 faculty and senior research staff and 70 graduate students, the laboratory conducts research in the areas of design, analysis, and control of manufacturing processes and systems.

This research is conducted through industrial consortia, sponsored research projects, and government grants. LMP's major areas of interest include production system design, precision engineering, three-dimensional printing (3DP), rapid autonomous machining, reconfigurable tooling, droplet-based manufacturing, automatic identification, continuous casting monitoring, machine elements and systems design, tribology , microcellular plastics, microelectromechanical systems (MEMS), and environmentally benign manufacturing (EBM).

In addition, LMP works closely with many other departments, labs, and programs at MIT including the Singapore-MIT Alliance, the Leaders for Manufacturing Program, and the Lean Aerospace Initiative. Many of our research projects are also conducted in collaboration with companies. In total, the laboratory works with about 50 different companies worldwide. Our government support, which is often coordinated with industrial support, comes from a variety of agencies—Department of Defense, National Science Foundation, National Aeronautics and Space Administration, and Department of Energy.

LMP experienced a slight decrease in funding for the year 2001–2002 with a research volume of $3.4 million. A few projects contributed disproportionately to this volume—notably the work of Professor Ely Sachs (3DP), Dr. David Cochran (production systems design), and Professor David Trumper (precision engineering).

Highlights and Awards

In the past year, Professors Jung-Hoon Chun, Emanuel Sachs, and Nam Suh were all on sabbatical. Professor Suh stepped down as head of the Department of Mechanical Engineering, Drs. Sang Gook Kim and Martin Culpepper joined us as associate professor and assistant professor, respectively. Dr. David Cochran became a principal research scientist. Professor Gutowski became the associate head of the Department of Mechanical Engineering.

This year Professor Sang Kim joined the laboratory. Professor Kim's interests are focused on MEMS for microphotonics and nano-manufacturing projects. These include MEMS optical switches by direct-photonic-beam steering, strain-tunable optical gratings, lasers and photonic crystals, large-strain piezoelectric micro actuators, piezoelectric micro-power generators, and nano-pelleting of carbon nanotubes.

Professor Martin Culpepper also joined the laboratory this year. Professor Culpepper's research looks at various precision-fixturing problems, including adjustable precision-fixturing concepts for a variety of applications ranging from automotive to weapons.

Dr. David Cochran's program in production system design continues to expand in new areas. This year Dr. Cochran captured important funding in aerospace systems analysis, supply chain design, and factory redesign.

Dr. Stanley B. Gershwin continues both his high level of activity with the Singapore-MIT Alliance and his systems research, which is currently focused on complex manufacturing systems-analysis models. This year he was honored with two important awards—the Best Paper Award for the IIE *Transactions* focus issues on Design and Manufacturing for 2000–2001, and the Outstanding IIE Publication Award for 2000–2001.

Professor David Hardt has taken a principal leadership role as liaison faculty in manufacturing to the Singapore-MIT Alliance. As part of his responsibilities, he has developed a MEng degree program in manufacturing for Singapore. This highly integrated set of courses that cover topics in processing, equipment, automation, process control, systems and product design, as well as basic business issues, was introduced to Singapore by MIT faculty last summer. Professor Hardt has also expanded his research into new areas including space interferometry.

Professor Samir Nayfeh is developing significant new research in precision machine design, mechanical power transmission, machine dynamics, and control. This year he initiated significant new research in the design of new bias ply weaving systems and equipment for composite materials.

Professor Sanjay Sarma, the Cecil and Ida Green career development professor, was awarded the Keenan Award for innovation in undergraduate education this year. He has continued to be active in the Auto-ID Center, which he co-founded with his colleagues Dr. David Brock and Professor Kai-Yeung Siu. The center's mission is to create an intelligent infrastructure to connect physical objects to the internet and to each other. This consortium continues to grow with applications to inventory control, material tracking and reordering, and material and product

recycling. The center now has over 50 sponsors and has started a sister center in the University of Cambridge, England. Professor Sarma has also continued his work in computer aided design/computer aided manufacturing/ computer numerical control and haptics. A new computer aided design/computer aided manufacturing system developed by his group is now in negotiation for licensing. He has also designed and constructed a new five-axis milling machine which combines parallel kinematics with serial kinematics.

Professor Alex Slocum has been active in evolving precision engineering fundamentals for MEMS applications, including micro-electronics sub-micron wafer-to-wafer positioning location accuracy, and the MEMS manufacture of "nanogate" flow control valves, with valve openings that can be controlled from 0 to 2,000 nanometers in 2 nanometer increments. He has also developed a ceiling-based magnetic wheel robot (magnewheelbots) for hospital automation. These robots have two magnetic wheels that enable them to hang like a pendulum

from steel sheets fastened to the ceiling and walls. They can drive across the ceiling and down walls, enabling them to travel between floors without the need for elevators because they can use stairwells.

Professor Nam Suh's new book on axiomatic design has been published by Oxford University Press, and his previous book, entitled *Principles of Design*, has been translated into Japanese and Korean.

Professor David Trumper was been very active in the development of the undergraduate mechanical engineering subject 2.003. In addition, his research program has continued in the areas of precision motion control and systems.

Professor Timothy Gutowski has redirected his research into the area of environmentally benign manufacturing, focusing of the development of "green engineering principles." He has started new projects on the design of a recyclable printer and on the environmental analysis of manufacturing processes. He has just finished projects on design guidelines for advanced composites fabrication and on the redesign of a flexible manufacturing system.

Timothy G. Gutowski
Director
Professor of Mechanical Engineering

More information about the Laboratory for Manufacturing and Productivity can be found online at http://web.mit.edu/lmp/www/.

Materials Processing Center / Microphotonics Center

This report discusses the FY2002 accomplishments of the Materials Processing Center (MPC) and the Microphotonics Center. The MIT Microphotonics Center was created within the MPC and is currently administered by MPC staff; it will be treated as a separate entity within the context of this report.

The Materials Processing Center is an interdisciplinary center within MIT's School of Engineering. Currently directed by Professor Lionel C. Kimerling (Department of Materials Science and Engineering), the MPC was established in 1980 in response to a recognized national need to improve the materials processing knowledge base and streamline the process of technology transfer within the materials science and engineering field. The MPC provides the MIT materials community with leadership in research program development and administrative support.

The mission of the MPC is to provide an environment where students and professionals from industry, government, and academia collaborate on pivotal multidisciplinary issues in materials science in a way that creates new knowledge, produces knowledgeable and capable employees, and promotes the exchange of information in the service of our country and in the context of a global community. In accomplishing its mission, the MPC reaches out to students, faculty, and industry.

The mission of the MIT Microphotonics Center is to build interdisciplinary, intramural research teams focused on advancing basic science and emerging technology in areas relevant to the creation of new materials, structures, and architectures to enable the evolution of photonics from single discrete devices to strongly interacting, integrated photonic systems. The research of the center is organized as a highly coupled set of activities that allow for individually driven discovery within a context of goal-oriented research. The basic programmatic units are theory and design, materials and processing, and characterization and performance. Students are expected to master a vertically integrated set of skills that extends to the fabrication of functional prototypes.

Materials Processing Center

Because of the interdisciplinary nature of the field of materials processing, faculty and research staff affiliated with the MPC come from a wide range of fields. Affiliated faculty and research staff number over 200 and hail from the Departments of Aeronautical and Astronautical Engineering, Biology, Chemical Engineering, Chemistry, Electrical Engineering and Computer Science, Materials Science and Engineering, Mechanical Engineering, Nuclear Engineering, Ocean Engineering, and Physics. Faculty and researchers from the Francis Bitter Magnet Lab and Lincoln Lab also participate in MPC programs.

For affiliates, the MPC serves as a bridge, via its Industry Collegium, to bring research results to industry's attention.

The MPC Industry Collegium is made up of over 40 domestic and international companies in a range of industries, from traditional commodity materials to biomaterials. For member companies, the collegium serves as a window on cutting-edge materials research and development at MIT. Researchers at MIT have the common agenda of leading-edge research and goal of maximum technological impact. The MPC collegium, in collaboration with MIT's Industrial Liaison Program, facilitates the transition of groundbreaking science into market-changing products by providing a pathway for technology transfer between the university and industry. This effort includes leveraging core federal research funding into expanded industrial-academic collaborations.

During much of FY2002, the MPC continued to focus on the development and expansion of the Microphotonics Center. Total research volume expanded by 50 percent to reach a total of $11.9 million. The combined MPC/Microphotonics Center staff grew to eight during FY2002. The two centers share staff, office space, and resources with the Microphotonics Center operating as an administrative sub-center of the MPC. Later in this report is a description of the activities of the Microphotonics Center during FY2002.

Awards

Affiliated faculty and research staff have over FY2002 been recognized with awards too many to be listed here. Please see the FY2002 issues of our newsletter, the *Industry Collegium Report*, for details. The report is available on the web at http://web.mit.edu/mpc/www/.

Education

One pillar of the MPC is the education of the next generation of materials processing research scientists, engineers, and leaders. To this end, the MPC initiates programs to enhance the intellectual vitality of the materials processing community at MIT. We measure the value of these programs by the breadth of the materials science they address, by the new and creative collaborations among researchers they catalyze, and by the degree of attention to the multidisciplinary—but at the same time fundamental—nature of materials processing they generate.

Materials Unlimited Seminar Series

Now in its fourth year, the Materials Unlimited Seminar Series highlights the research of senior graduate students identified by their peers and faculty members as being among the best in MIT materials-related research. Seminars include a half-hour talk by the featured graduate student, followed by a half-hour panel discussion.

Panelists are drawn from MIT, other university faculty, and companies appropriate to the topic. Seminars are well attended by a diverse audience of faculty, postdocs, and students, as well as industrial guests.

FY2002 featured three talks:

—"Patterning and Controlled Microstructures of Ultrathin Layer-by-Layer Thin Films: From Polymers to Mesoscale Colloidal Assembly" was the title of Xueping Jiang's (Chemical Engineering) talk. Professors Paula Hammond, Michael Rubner, and Joseph Jacobson, as well as Dr. Carmichael Roberts (president, Surface Logix, Inc.), served as panelists for her talk.

—Michael Groenert (DMSE) spoke about his work with "GaAs/AlGaAs Quantum Well Lasers on Si," with Professors Rajeev Ram (EECS), Eugene Fitzgerald (DMSE), and Lionel Kimerling, and Dr. John Carlin (AmberWave Systems Co.) as panelists.

—Finally, Krystyn van Vliet (DMSE) described to the audience her research in "Nanoindentation: Experiment and Simulation of Surface Contact at the Atomic Scale," with panelists Professors Subra Suresh (DMSE) and Franz Spaepen (Harvard University), and Dr. Ju Li (Nuclear Engineering) as panelists.

Materials Day

The sixth annual Materials Day celebration was held in October 2001 under the title and theme "Nanostructured Materials: Foundation for the Next Generation of Optical and Electronic Devices." Talks included:

- Structured Organic Materials in Active Optoelectronic Devices—Professors Vladimir Bulovic (EECS) and Timothy Swager (Chemistry)
- Organic Lasers—Dr. Marc Baldo, Princeton University (now MIT EECS)
- Approaches to Nonlithographic Assembly: From Polymer Multilayers to Colloidal Particles—Professor Paula Hammond (Chemical Engineering)
- Molecular-Level Processing of Polymers: A Means to Control the Function and Performance of Thin Film Devices—Professor Michael Rubner (DMSE)
- Raman Spectroscopy of One Isolated Carbon Nanotube—Professor Mildred Dresselhaus (MIT Institute Professor)
- Nanocrystalline Perovskites for Catalytic Combustion and Membrane Reactions—Professor Jackie Ying (Chemical Engineering)
- The Role of Lithography and the Planar Process—Professor Henry Smith (EECS)
- The Colorful World of Semiconductor Nanocrystals—Professor Moungi Bawendi (Chemistry)
- Logic Elements and Microelectromechanical Systems (MEMS) from Nanoparticle Building Blocks—Professor Joseph Jacobson (Media Lab)
- Photonic Band Gap Optical Fibers and Devices—Professor Yoel Fink (DMSE)
- Block Copolymer Based Photonic Crystals—Professor Edwin Thomas (DMSE)

The late afternoon program featured a poster session open to graduate, undergraduate, and postdoctoral researchers in materials science. One hundred seven presenters defended 82 posters, a record high for the six years of Materials Day poster sessions. Three posters were awarded a $500 prize for best poster as judged by a panel of faculty and industry judges. The winners were Dr. Heidi Burch (DMSE), Vikram Sundar (Chemistry), and Augustine Urbas (DMSE). The keynote speaker for the evening program was Professor Mark Thompson of the University of Southern California Chemistry Department, who addressed the audience about "Strategies for Achieving a Bright Future."

For the first time, the MPC provided a live webcast of the Materials Day morning program talks. More than 100 hits to the webcast access page were logged.

Summer Research Internship Program

The MPC and Center for Materials Science and Engineering (CMSE) co-sponsor the MPC-CMSE summer research internship program. This 10-week program brings outstanding juniors and seniors in science or engineering majors from academic institutions around the United States to MIT to work in the laboratories of participating faculty and hear weekly talks on subjects of relevance to budding materials researchers. Summer 2001 saw a doubling of our outreach effort in this program, with 17 students attending from a wide range of schools, including the University of Iowa, Colorado State, the University of Southern Mississippi, Columbia University, and the University of Rochester. These students worked with faculty from Chemical Engineering, Mechanical Engineering, DMSE, the Active Materials and Structures Lab, and the Magnet Lab on a wide variety of projects.

During FY2001 the decision was made to expand the summer research internship program, and the summer 2001 session, just begun at the time of this report, has brought 21 students to MIT.

Other

The MPC supports the MIT Solar Car and Formula SAE teams with a $5K grant each. See http://u6.mit.edu/activities/solar-cars/ for information about this student organization.

Research

Research volume statistics have been given above. Details on the CY2001 research by MPC-affiliated faculty can be found in our 2001 annual report, *Materials Research at MIT 2002*, available online via a link from our home page.

Outreach

The second pillar of the Materials Processing Center is its outreach to new faculty and researchers across MIT's materials community, as well as to the global materials industry. The center is proactive in inviting faculty to participate in center activities, whether through our publications, educational programs, ongoing research programs or the development and marketing of new initiatives. Seed funding for young faculty is also available.

Industry Collegium

The MPC Industry Collegium continues to provide two-way access and exchange between our materials community faculty and the international industrial community.

Publications

The Microphotonics Center produces two main publications in pursuit of its outreach goals. *Materials Research at MIT* is a digest of materials research performed at MIT by MPC-affiliated faculty and others during the previous calendar year. It provides a short summary of each project being researched by faculty members, along with a list of their personnel and publications. *Materials Research at MIT 2002* provided the reports of 77 faculty members. This research digest for CY2001 was issued in both print and electronic (web and, new this year, a searchable CD-ROM) formats. We continue to increase our use of the web for dissemination of information, during 2001 providing web site construction, web hosting, and web-based file exchange services for the nascent Institute for Soldier Nanotechnology.

The MPC's other major publication is the *Industry Collegium Report*, a thrice-yearly newsletter on the activities of the MPC. Distribution for both of the main publications includes MPC-affiliated MIT faculty and staff (>200) and members of the MPC Collegium mailing list (>400).

Faculty Outreach

The MPC has added several new faculty members to its affiliated faculty pool—Darrell Irvine (DMSE) and Eric Hudson (Physics).

Microphotonics Center

The MIT Microphotonics Center was announced in the fall of 1998 by the Materials Processing Center and commenced activity by the pooling of intellect and ongoing research funds of a group of faculty. The participating faculty had been working in loose collaboration across a variety of subjects ranging from components for telecommunications and computing to optical coatings. The driving forces for the organization were the amplification of the synergy that had been realized through the multidisciplinary collaborations, and attraction of industrial support to MIT research.

The center is currently administered by the staff of the MPC. Center activities are highly interdisciplinary. Microphotonics Center–affiliated faculty currently number 30 and represent seven departments across three schools: Mechanical Engineering, EECS, Chemical Engineering, DMSE, Chemistry, Physics, and the Sloan School. During FY2002, we have added Karen Gleason (Chemical Engineering), Franz Kaertner and Munther Dahleh (both of EECS), Adam Powell (DMSE), and Martin Culpepper and Alexander Slocum (both of Mechincal Engineering) to the pool of faculty affiliated under the Microphotonics Center umbrella.

One of the major Microphotonics Center activities has been and continues to be a diligent effort creating the world's best processing facility for photonic components. The research areas have been designed and programmed for theory and design work; layered growth of III-V, Si-based dielectric, and organic components; fabrication of prototype passive dielectric-based components (e.g. waveguides) and active compound semiconductor-based components (e.g. lasers, detectors); an area for research on and prototype construction of displays based on novel organic materials; a photonic component packaging facility; and full characterization facilities.

Industry partners are supporting the equipment infrastructure with $5.5 million in equipment donations (all currently in storage awaiting facility availability), and we are actively supporting the capital campaign in a major effort to secure support for the dedicated space. In the near term, we are partnering with MTL, RLE, and CMSE to renovate temporary space in distributed "migration" facilities, so that we can maintain research leadership even as we continue to look forward to a consolidated facility and the synergies that it will bring to Microphotonics Center research.

Education

The Microphotonics Center is dedicated to providing a community of researchers and engineers educated in technical and business-strategy issues of this emerging field. The center sponsors a weekly seminar series, which is attended on average by over 50 faculty, postdocs, students of all levels, and visitors. Speakers have included MIT and other university faculty, postdocs and senior graduate students, and industrial visitors. For a list of past and future seminar topics and speakers, see our home page at http://mphotonics.mit.edu/.

Research

One particular focal area for Microphotonics Center research is in new materials, structures, and architectures for planar lightwave circuits. The goal is fully integrated photonic functionality for these tiny, low-cost units, thereby enabling their deployment in metropolitan area network and fiber-to-the-home applications. Our areas of emphasis include dense wavelength-division multiplexing (a way of increasing signal-capacity), optical signal conditioning, on-chip optical clock distribution and I/O for microprocessors.

Our research has set world records for performance at 1.3- to 1.55-micron wavelengths (the standard for optical communications). We have achieved the *smallest* waveguide bends (1 micron bend radius); the *smallest* ring resonators (1 micron radius); the *first* coupled quadruple micro-ring resonator structures for high-definition channels; the *smallest* multimode interferometer beam splitters (1-by-8 in 7.5-by-15 microns); the *smallest* in-line add/drop filter (0.055 cubic micron volume); the *smallest* multichannel add/drop and multiplex/de-multiplex circuits; the worldwide *best* performing waveguide-integrated Ge photodetectors for the 1.3- to 1.55 micron wavelengths; the *first* erbium-doped silicon light-emitting diode; and the *first* terahertz oscillator based on an erbium-doped microcavity. Beyond these, we have engineered a range of components based on photonic crystal concepts to enhance the extraction efficiency of light sources and route signals in high-level cross-connect circuits.

See the 2001 research digest, *Bringing New Technology to Light*, for information on research projects and for details on the progress of the groundbreaking research cited above. This book is available online via a link from the Microphotonics Center home page.

Microphotonics Center research sponsored by our research alliance partners and others has generated approximately 150 new invention disclosures over the past five years and 11 new startups have been launched by our materials community over the same period. In FY2002 Microphotonics Center research volume was $2.7 million for over 20 faculty members, and these faculty members published some 245 papers in the microphotonics area.

The Microphotonics Center industry consortium began its key initiative, the Communications Technology Roadmap Project (CTR) in the fall of 2000. This ongoing study will give a 10-year view down the rapidly changing microphotonics technology highway by interviewing industry workers at all levels of management and developing a picture of areas of consensus and conflicting opinion on how technology and business issues will play out. Consortium members will use the study findings in optical network architecture, component design and manufacturing, market analysis, technical supply chain analysis, and geographic analysis to focus their R&D and business strategies. The CTR project is chaired by Professors Charles Fine (Sloan) and Rajeev Ram (EECS), and has Elizabeth Bruce as a dedicated (part-time) research staff member. The CTR working group presented interim reports to consortium members at the January and April 2002 meetings; the first formal report of the roadmap study committee will be distributed to industry consortium member companies in November 2002. For more information about CTR, see the web site at http://mph-roadmap.mit.edu/.

Outreach

As with the MPC, outreach, both to researchers within MIT and to industry, is the *sine qua non* of the Microphotonics Center.

Industry Consortium

The Microphotonics Center has established an industry consortium to create a proactive forum where researchers from MIT and from industry can work as partners in defining and pursuing critical microphotonics R&D. Like the MPC's Industry Collegium, the Microphotonics Center Industry Consortium provides a bridge between MIT technology and potential commercialization. The founding member companies of the consortium share royalty-free licensing to all research funded by the consortium and participate in the information technology research project. The consortium has 12 founding member companies and ongoing talks with others, whose businesses represent the entire industry supply chain from service providers to basic materials suppliers. The consortium held a kickoff meeting in January 2002 and a follow-up meeting in April 2002.

Coupling and Packaging Consortium

The Microphotonics Center is in the process of establishing a Coupling and Packaging Consortium (CPC), with Professor George Barbastathis (Mechanical Engineering) as its director, to address issues of microphotonic component coupling and circuit packaging. The consortium will serve as a rubric for research funded and shared by the member companies, and was introduced at the January 2002 Microphotonics Industry Consortium meeting. Proposals will be solicited from faculty during the summer of 2002. As of the end of FY2002, the CPC had membership commitments from three companies and has active discussions and negotiations ongoing with a number of other prospective members

Major Agreements for Fiscal Year 2002

In April 2001, MIT and Walsin Lihwa Corporation, the leading Taiwanese DRAM (Dynamic Random Access Memory) manufacturer and cable/wire supplier, signed a major agreement to collaborate on research via the Microphotonics Center. The five-year master sponsored research agreement provided $3M in the first year to

research designs and processes for laser diodes and lightwave components for compact and low-cost dense wavelength-division multiplexing systems. The research alliance with Walsin Lihwa was renewed in April for a second year at $5 million.

In November 2001, MIT and Pirelli Labs, the optical communications research arm of the Italian Pirelli group, signed a five-year master sponsored research agreement for advanced basic research in the field of photonics via the Microphotonics Center. In the first year Pirelli Labs has sponsored $2 million in research that supports six coordinated faculty research teams.

Program Expansion

During the past year the Microphotonics Center held a number of major research briefings for individual domestic and international corporations. New industry partnerships have resulted in the launch of a five-year master sponsored research initiative with Analog Devices as well as major equipment donation from Veeco and Unaxis.

Publications

The Microphotonics Center continued to print *Bringing New Technology to Light*, a digest of relevant research by Microphotonics Center–affiliated faculty. This volume is similar to the Materials Processing Center's annual research digest, described above, and was issued in print and electronic (web and searchable CD-ROM) formats. In the coming year we will eliminate the print version of this research report entirely, providing it only on CD-ROM and via the web. We continue to increase our use of the web for dissemination of information, particularly to our collegium member companies.

Outlook

The Materials Processing Center and the Microphotonics Center continue to serve as a valuable bridge between MIT materials and microphotonics research, respectively, and industry. Our goals for the future include the expansion of this role as well as a reaffirmation of our role in educating the local community in materials and microphotonics through our seminar series and through the MPC-CMSE summer research internship program. We expect to expand and develop our web presence in the coming year to provide more educational content for the general public on the relevance of the research conducted within our areas.

For both organizations, our outreach efforts both within MIT (to involve more faculty, and particularly young faculty) and outside MIT (to develop company ties to the MPC Industry Collegium and the Microphotonics Center Industry Consortium, as well as through one-on-one research sponsorship or alliance programs) will continue apace. Additional goals for the Microphotonics Center will be the establishment of our Coupling and Packaging Consortium, ongoing work on our Communications Technology Roadmap Project, and development of our infrastracture resources. Our publications, including our web site, remain a key part of that effort. We hope to launch, during 2002, a Microphotonics Center newsletter similar in format to the MPC newsletter.

Lionel C. Kimerling
Director
Thomas Lord Professor of Materials Science and Engineering

More information about the Materials Processing Center can be found online at http://web.mit.edu/mpc/www/.

More information about the Microphotonics Center can be found online at http://mphotonics.mit.edu/.

Microsystems Technology Laboratories

The Microsystems Technology Laboratories (MTL) conducts research and education with an intellectual core of semiconductor industry process and device technology, and integrated circuits and systems design. MTL also leverages its infrastructure to foster new initiatives at the Institute and to support the general micro- and nano-fabrication needs of MIT.

MTL carries out graduate and undergraduate research activities in circuits and systems that are built using microsystems technology for applications such as wireless sensing networks and intelligent vision systems. Additionally, researchers are investigating the fabrication and study of small (i.e., micrometer to nanometer) structures and their use for the implementation of interesting integrated devices from nanometer-scale electronic devices to optical switches to displays to biosensors to micropower generators.

MTL facilities include laboratory space for electronics test and assembly, computation and communication, and microfabrication. MTL microfabrication facilities include three clean rooms with a total of 6,500 sq. ft.; the state-of-the-art class-10 Integrated Circuits Laboratory, the flexible process environment Technology Research Laboratory, and the Exploratory Materials Laboratory.

In AY2002, the MTL fabrication facilities were utilized by approximately 350 students and staff. The laboratory manages a contract research volume of approximately $7 million per year. In addition, approximately $30 million of contract research (managed in other departments/ labs/centers) supporting 45 faculty and senior research staff utilizes the MTL facilities as an integral part of their research. The fabrication and computation facilities of the MTL are maintained and operated by a full time technical staff of 21 technicians and engineers.

Beyond the research programs, MTL supports several educational initiatives that leverage the research infrastructure of the labs. Chief among them is the undergraduate microfabrication laboratory, a lecture/ laboratory course in which 120 students per year are afforded the opportunity to microfabricate an electronic device in the state-of-the-art MTL facilities. Additionally, we offer a project laboratory for team-based design of microfabricated structures. The Technology Demonstration Laboratory, developed by Professor Sodini, is housed in MTL and provides EECS MEng students the chance to work on thesis topics with a technology integration and demonstration focus. Lastly, via the i-Campus Initiative, Professor del Alamo is developing a series of web-based laboratory tools that permit testing of microfabricated structures.

MTL maintains a strong and vibrant interaction with industries that value not only the research output, but also the students that are educated in state-of-the-art microsystems technology. MTL facilities are supported in part by industry through the MIT Microsystems Industrial Group (MIG), whose current members include Advanced Micro Devices, Analog Devices, Applied Materials, IBM, Intel Corporation, Agere, Motorola, Inc. National Semiconductor, Novellus Systems, Texas Instruments, and Taiwan Semiconductor Manufacturing Corporation. Three industry-funded centers are also housed in MTL: the Center for Integrated Circuits and Systems, the Intelligent Transportation Research Center, and MEMS@MIT.

Highlights

The upgrade of the MTL fabrication facilities to six-inch wafer-processing capability was fully completed this year. This upgrade positions the MTL community to perform leading-edge research with a tool set that is not matched by any research university in the world. The upgrade cost more than $13 million, with $12 million of those costs supported by donations of cash and state-of-the-art tools by our MIG. The completion of the upgrade and several other tool installations bring the installed capital base of tools in MTL to approximately $50 million. This year we recorded the highest process activity ever in the history of MTL, a testament to the utility of this tool base.

MTL played an active roll in the successful award of the Institute for Soldier Nanotechnologies (ISN) at MIT. The shared experimental facilities of MTL will be utilized by this new center, and in addition, MTL will create space for dedicated ISN equipment within the Building 39 envelope.

This year we implemented a new program to assist the transfer of technologies developed in MTL. Specifically, we have created a trial program that affords companies that have licensed technology developed in MTL to utilize the MTL facilities for a transition phase. The intent is to provide access to expensive facilities in an incubation phase while these companies establish finances and facilities of their own. We are trying this program with MicroCHIPS, Inc. (http://www.mchips.com/). The drug delivery technology that is the core of this company was developed in the MTL facilities. As part of the program, MicroCHIPS personnel are working in the MTL facilities in return for payment of fees which support the cleanroom.

Professor Mike Perrott joined the laboratory faculty this year. In his research, he focuses on high-speed circuit and signal processing techniques for data links and wireless applications. Mike complements a strong team of faculty (Chandrakasan, Lee, and Sodini) working in the integrated systems area of the lab.

Work continued to identify overlap in microfabrication needs between MTL and the Microphotonics Center. Many opportunities exist for sharing of resources and

leveraging existing infrastructure, and we will continue to work in cooperation to identify these opportunities. In the near term, we are working on a plan to integrate several key microphotonics process tools into the MTL space. These exciting additions will complement and expand the fabrication capabilities of MTL.

Future Plans

MTL's research and education initiatives have expanded approximately tenfold in the past 15 years without a significant growth in the space allocation to the laboratory. This has created intense pressure on researchers in the laboratory and has forced us to continuously work to optimize the use of space in the laboratory. It is clear the primary limitation on growth of the laboratory into logical new research areas is the availability of space to accommodate this growth, and funding to support the shared infrastructure.

As part of our strategic planning process, we have identified four primary initiatives. First, we want to maintain a preeminent micro/nanofabrication infrastructure for the Institute. Second, we want to foster new initiatives at the Institute that leverage this infrastructure. Third, we want to promote interactions between the circuits/systems community and the micro/nanofabrication community in MTL. Fourth, we want to develop a more diversified funding structure to support the MTL infrastructure. As part of this plan, we have some immediate actions as detailed below.

We will add process tools, particularly in support of the microphotonics program. In addition, we will be adding space and capability for nanoscale fabrication under the Institute for Soldier Nanotechnologies. We will continue to explore opportunities to improve MTL's ability to serve the campus's micro/nano fabrication needs. Part of this includes pursuit of new revenue streams to underwrite the infrastructure.

We will continue to explore mechanisms to produce intellectually vibrant links between the two primary research constituents of the lab—the circuits and systems design community and the micro/nanofabrication community. In addition, we will continue to pursue opportunities for cross-cutting research that leverages the intellectual infrastructure of the MTL.

Martin A. Schmidt
Director
Professor of Electrical Engineering and Computer Science

More information about the Microsystems Technology Laboratories can be found on the web at http://www-mtl.mit.edu/.

Program in Polymer Science and Technology

The Program in Polymer Science and Technology (PPST), founded in 1986, is an interdepartmental program offering graduate education in the interdisciplinary field of polymer science and engineering. Its goals are to provide educational opportunities and to foster a spirit of community and collaboration among the large and widespread group of students, faculty, and visitors involved in polymer-related activities at MIT.

The program consists of a core curriculum, written and oral qualifying procedures for doctoral studies, and continuing education opportunities through seminars, visitors from industry and academia, and research competitions. It is administered by faculty from the Departments of Materials Science and Engineering, Chemical Engineering, Mechanical Engineering, and Chemistry. PPST also serves as a focal point for information and opportunities in polymer-related fields at MIT.

There were 34 students enrolled in PPST in academic year 2002, with home departments in the four disciplines from which PPST draws its faculty. This year the program graduated four students with PhD degrees. Six new PPST students were admitted into the program from the Departments of Chemical Engineering (four) and Materials Science and Engineering (two).

Two new professors were added to the PPST faculty: Professor Darrell Irvine from the Department of Materials Science and Engineering, and Professor Pat Doyle from the Department of Chemical Engineering. Professor Ali Argon (Mechanical Engineering) and Professor Ed Merrill (Chemical Engineering) both stepped down from PPST faculty positions due to retirement.

The PPST weekly seminar continues to attract an average of 50–80 students, faculty, and visitors per seminar. This past year, lectures were presented by leading polymer faculty from a number of US and European universities as well as from faculty and senior students within MIT. Professor Paula Hammond (Chemical Engineering) continued in her role as organizer for the seminar series through the fall term; Professor Christine Ortiz (Materials Science and Engineering) took over seminar organization beginning with the sSpring term.

In spring 2002, PPST instituted the first OMNOVA Signature Award for excellence in polymer research, sponsored by the OMNOVA Foundation. This competition produced two student awardees, Amy Grayson and Xueping Ziang, who each received a cash award and invitations to present their award-winning research in a special PPST seminar. The awardees' faculty advisors, Professor Michael Cima, Professor Bob Langer, and Professor Paula Hammond, were also recognized.

Gregory C. Rutledge
Director
Associate Professor of Chemical Engineering

More information about the Program in Polymer Science and Technology can be found on the web at http://web.mit.edu/ppst/.

Singapore-MIT Alliance

The Singapore-MIT Alliance (SMA) is a global partnership in graduate education between MIT, The National University of Singapore (NUS), and Nanyang Technological University (NTU). The goals and aims of SMA are threefold:

- To set a new standard for international collaboration in graduate research and education
- To invigorate engineering education in Singapore
- To strengthen MIT through the extension of its global impact, the enhancement of its curriculum, and the improvement of its infrastructure

Partnership

SMA was initiated on January 1, 1999, with the first two of its five programs: Advanced Materials for Micro- and Nano- Systems and High Performance Computation for Engineered Systems, which began on July 1, 1999. A third program, Innovation in Manufacturing Systems and Technology, was introduced the following July, and the last two programs, Molecular Engineering of Biological and Chemical Systems and Computer Science, got underway on July 1, 2001.

The academic calendar, course content, grading method, and degree requirements of SMA follow MIT practice and standards, to a large extent. Degrees are conferred by the host university (NUS or NTU), along with an MIT-cosponsored SMA certificate confirming completion of the program of study.

Each program has a minimum of six faculty members from MIT and an equivalent number from either NUS or NTU, each of whom devote up to half of their time to SMA and are designated as SMA faculty fellows. Programs also have SMA associates who assist the fellows by giving several lectures each year. For AY2002, 41 MIT faculty participated in SMA.

Subjects are taught primarily by distance education. However, MIT faculty fellows also spend several weeks a year in Singapore, and some faculty have spent or will spend eight weeks or an entire semester, engaging in face to face lecturing, discussion, and research collaboration.

All SMA students spend at least two weeks at MIT during their matriculation; doctoral students will spend an additional full semester at MIT. In addition, an annual symposium is held in Singapore to evaluate progress, and to enable students and faculty to interact with industry.

Research comprises an important aspect of the research master's and doctoral degrees in all five programs. As part of the curriculum, through industry-sponsored research projects, students have the opportunity to work with some of the most technologically advanced companies in the world through specific industry projects. An MIT and a Singaporean faculty member jointly supervise research students' theses.

Management Structure

SMA is governed at three levels. At the top tier is the governing board, comprising academic, government, and industrial leaders in Singapore and members of the faculty and administration at MIT. At the next level is the joint academic committee, comprising administration and faculty from both MIT and Singapore, which meets quarterly (usually via videoconferencing). Finally, the five academic programs are co-directed by program chairs, one each from MIT and Singapore.

Administratively, SMA is managed by two co-directors and two co-deputy directors. On the MIT side, Professor Anthony T. Patera serves as director of the MIT Center for the Singapore-MIT Alliance and Professor Steven Lerman serves as the deputy director.

Summer Conference

All SMA students spend two and one-half weeks at MIT at a summer conference designed to help Singaporean students become immersed in the MIT environment and the SMA program. There are two components to the summer conference: pre-immersion and immersion. The pre-immersion component consists of discussions with entrepreneurs in their respective fields, while the immersion program includes English-language workshops, lectures, and lab sessions taught by MIT faculty, and social gatherings and activities.

Distance Learning

MIT's Academic Media Production Services (AMPS), under the direction of assistant provost Vijay Kumar, has assumed responsibility for the technology and operation of the distance-learning aspects of SMA. SMA staff work closely with AMPS staff in selecting modes of operation and necessary equipment through a joint SMA distance-education working group. This group assisted with recommending the distance-learning equipment that is currently used in Rooms 1-390, 3-370, 8-404, and three research interaction rooms. In addition, the AMPS staff also works closely with the SMA staff to update the SMA web site.

Entering Class

A total of 1,974 applications were received for the five programs operating in academic year 2002–2003. To date, 317 offers have been made, and 188 applicants accepted their offer. Of these, 38 percent were from China, 24 percent were from Singapore, 17 percent from India, and the remainder from other Southeast Asian countries.

GRE scores were waived for students from top schools in Singapore. However, those student scores obtained compare favorably with the scores of students being admitted to graduate school in MIT's Departments of Aeronautics and Astronautics, Leaders for Manufacturing, Mechanical Engineering, and Materials Science and Engineering. Both GRE and TOEFL scores for the class of 2003 are slightly higher than those for last year's class. Besides the draw of the MIT name, one factor that has aided in recruitment of top students is the fact that all students are offered full fellowship support (including travel costs) for their entire matriculation.

The targeted number of students enrolled in each program is 50; approximately 35 professional master's students enrolled in a one-year (12-month) course of study, with the remainder enrolled as research master's or doctorates.

Noteworthy Events in 2002

SMA embarked on a number of important outreach programs this year. Specifically, the 2002 symposium in Singapore was attended by dignitaries such as President Vest, Provost Brown, Chancellor Clay, Dean Magnanti, deputy prime minister of Singapore Tony Tan, and Singapore's minister of education, Admiral Teo.

Nobel laureate Phillip Sharp kicked off the SMA/ILP seminar series in the fall of 2001, and was followed by a spring seminar given by Professor Lester Thurow. Not all activities are seminars—music professor Marcus Thompson conducted a master class in music. Outreach activities serve to share our distance education facilities and capabilities with other departments at MIT, NUS, and NTU.

Advanced Materials for Micro- and Nano-Systems

The SMA degrees in Advanced Materials for Micro- and Nano- Systems (AMM&NS) offer broad foundations in advanced materials. They cover the fundamentals of electrical, optical, magnetic, and mechanical properties of materials, and the fundamentals of materials processing for high-technology applications, with an emphasis on applications in microelectronics.

The SM degree (a professional master's degree) in advanced materials constitutes a 12-month program, including three subjects in the necessary fundamentals, and three electives with a focus on microelectronics. The degree also offers students an opportunity to carry out a semester-long research or industry project. The MEng degree (a research master's degree) includes a similar, but more rigorous, core curriculum and a master's thesis jointly supervised by SMA fellows from Singapore and MIT.

The PhD degree includes an expanded choice of elective subjects and a minor subject selection outside the materials area.

A number of innovations in distance education are being developed through the SMA program. In fall 1999, a new tool, "Web-lab," developed at MIT (and partially supported by SMA) was successfully used to remotely operate device characterization equipment at MIT from NUS. This enables students to conduct real-time experiments while being 8,000 miles away. Expansion of this device is planned for next year

The research collaboration growing from co-supervision of MEng and PhD student research has already led to the submission of joint publications and presentations at an international conference. Joint research activities among the alliance universities and Singaporean research institutes continue to prosper, especially in the area of metallization and materials reliability in microelectronics.

The MIT chair of the AMM&NS program is Carl V. Thompson. Faculty members include Lallit Anand, Dimitri A. Antoniadis, Craig Carter, Gerbrand Ceder, Eugene A. Fitzgerald, Clifton G. Fonstad, and Mark Spearing as faculty fellows, with Nicola Marzari as an associate. Subra Suresh, head of the Department of Materials Science and Engineering, serves as the program advisor.

High Performance Computation for Engineered Systems

The SMA program in High Performance Computation for Engineered Systems (HPCES) is focused on high-performance computation simulation and optimization of engineered systems. High-performance computation is a crucial component in the modeling, simulation, design, optimization, control, and visualization of engineered systems in a wide range of technology and service industries. Students learn to apply and develop advanced numerical techniques for simulation and optimization relevant to a diverse set of applications from aerospace, electrical, industrial, mechanical, and other engineering fields, as well as logistics, management, and finance. The HPCES program has chosen effective computation for design and operation of engineered systems as its research theme.

The SM (a professional master's degree), MEng, and PhD degree programs all include a core curriculum; the MEng degree requires a master's thesis; the PhD degree requires several additional advanced courses and a doctoral thesis. The SM degree focuses on the critical and effective application, modification, and integration of existing simulation and optimization software. The MEng and PhD degrees emphasize the formulation, analysis, and implementation of new computational methods for the simulation and optimization of engineered systems.

From fall 2001 to spring 2002, seven subjects were taught to both SMA (via videoconferencing and taped lectures) and MIT students; four in the fall of 2001 and three in the

spring of 2002. The SMA students performed very well when compared with their MIT cohorts.

The MIT chair of the HPCES program is Jaime Peraire. Faculty members involved include Thomas Magnanti (program advisor), Dimitris J. Bertsimas, Robert M. Freund, Anthony Patera (codirector) and Jacob K. White as faculty fellows, with Nicolas Hadjiconstantinou, Georgia Perakis, Andreas Schulz, Gilbert Strang, and Karen Willcox as associates.

Innovation In Manufacturing Systems and Technology

Degree programs in Innovation in Manufacturing Systems and Technology (IMST) include the SM, the MEng, and the PhD. IMST offers highly competitive courses of study that explore the many facets of manufacturing technology. Challenging coursework integrates the process, product, system and business aspects of this vibrant industry, while focusing on the core of manufacturing systems. Advanced coursework will expose students to innovative theories and methodology, as well as a rigorous investigation of financial, strategic, and global aspects of technology innovation and new business generation.

The SM, MEng, and PhD degree programs all include a core curriculum: the SM degree includes a theme project, the MEng degree includes a Master's level research thesis, and the PhD degree includes additional subjects on advanced topics in each of the fundamental areas.

The SM degree program is aimed at practitioners who will use this knowledge to become leaders in existing, as well as emerging, manufacturing companies. The MEng and PhD degree programs prepares students for careers in industrial research and development centers, research institutes, or academic departments interested in fundamental research in manufacturing.

The MIT chair of IMST is David E. Hardt. Faculty members include Lallit Anand, Jung-Hoon Chun, Steven D. Eppinger, Stephen Graves, and Kamal Youcef-Toumi as faculty fellows, with Stanley B. Gershwin as an associate.

Molecular Engineering of Biological and Chemical Systems

The Molecular Engineering of Biological and Chemical Systems (MEBCS) Program offers two innovative courses of study (SM and PhD) that integrate a molecular understanding of biological and chemical phenomena with advances in process engineering for the life sciences and fine chemical industries. Through a combination of cutting edge research and advanced coursework in molecular engineering sciences, graduates are poised to accept high-level professional or research positions in thriving industries, new startup companies, academic institutions, and research centers.

The professional master's (SM) degree program prepares graduates for the shaping and solving of complex problems, resource management, teamwork, and leadership. The PhD program prepares graduates for advanced careers in industrial research and development centers, research institutes, or academic departments interested in biological and chemical engineering processes with emphasis on synthesis skills, engineering design, and interdisciplinary approaches.

The SMA program in MEBCS provides a unique and bold educational opportunity for graduate students interested in pursuing careers at the frontiers of life science and fine chemical technologies. Students attending this program have ample opportunity to work with some of the most technologically advanced companies in the world through specific industry projects. The MEBCS program is designed to prepare future leaders for positions in knowledge-driven industries poised for global economic growth in the new millennium.

The MIT chair of MEBCS is Jackie Y. Ying. MIT faculty members Robert A. Brown (program advisor), Alan T. Hatton, Paul E. Laibinis, Harvey F. Lodish, Kenneth A. Smith, Gregory N. Stephanopoulos, and Daniel I. C. Wang are SMA faculty fellows, while faculty member Bernhardt Trout is an associate.

Computer Science

The SMA program in Computer Science (CS) provides a unique educational experience for graduate students interested in careers in industry and research establishments. The students are exposed to the broad foundations of computer science, encompassing computer architecture, software systems, algorithms and advanced applications.

The SM in computer science is a one-year professional degree program based on coursework that prepares graduates for careers in the development of advanced computer systems. It is aimed at training students to apply their knowledge of computer science to industrial problems, particularly in the development of large software systems and embedded computing.

The PhD degree program in computer science is a research program that provides the necessary depth to equip graduates for careers in industrial research and development centers, research institutes or academic departments interested in cutting-edge research in all aspects of computer science.

The MIT chair of CS is Charles Leiserson. Faculty members Saman P. Amarasinghe, Alan Edelman, Leslie Kaelbling, Stuart Madnick, Tomas Lozano-Perez, Martin Rinard, and research scientist Larry Rudolph are faculty fellows.

Benefits and Goals

Singapore's goals for SMA include invigorating its engineering education, enhancing creativity and entrepreneurship in its educational system, and attracting talented young people to Singapore.

On the MIT side, an important benefit is that this highly focused, well-funded alliance gives us the opportunity to broaden our role as a global university, to define our own style of contact-intensive distance education, and to learn how to bring this global interaction to Cambridge to enhance the undergraduate and graduate education of our own students.

We anticipate strengthened departmental curricula as a result of SMA-funded course and subject development. We also anticipate enhanced inter-departmental and inter-school collaborations as a result of both SMA curriculum development and SMA-funded research projects. In fact, since the inception of SMA, 41 SMA courses—or 63 percent of the total number of the SMA classes offered—have been cross-listed at MIT. To date, over 1,000 MIT students have received credit for taking these cross-listed classes.

SMA continues to find ways to enhance teaching and research at MIT and at the two universities in Singapore.

Anthony T. Patera
Director
School of Engineering Professor of Teaching Innovation
Professor of Mechanical Engineering

More information about the Singapore-MIT Alliance can be found on the web at http://web.mit.edu/sma/.

Dean, School of Humanities, Arts, and Social Sciences

Several new developments in 2001–2002 in the School of Humanities, Arts, and Social Sciences (SHASS) merit special mention.

SHASS took the leadership role in launching the HASS-CI component of the Communication Requirement (CR), MIT's newest addition to the General Institute Requirements for undergraduates. The launch proved to be remarkably smooth and faculty are generally positive about the prospects for HASS-CI.

The first class of seven students was admitted to SHASS's newest graduate program, the SM degree in science writing, which is located in the Program in Writing and Humanistic Studies. These students will matriculate in September 2002. This new degree's mission is the improvement of the public understanding of science. The graduate program is directed by professor of science writing Robert Kanigel and will draw on the talented teaching staff of the Program in Writing and Humanistic Studies to support its curriculum. The faculty have high hopes for this program and see it as a major addition to SHASS's other programs that promote the public awareness of science and technology nationally and internationally: the Knight Science Journalism Fellowships, the Program in Science, Technology and Society, and the Comparative Media Studies Program.

The Center for International Studies (CIS) celebrated its 50th anniversary on May 15-16, with a wonderful celebratory dinner and colloquium. The celebration included the release of professor emeritus Donald L. M. Blackmer's monograph The MIT Center for International Studies: The Founding Years 1951–1969, a remarkable history of CIS's first two decades, and the announcement of a $10 million gift from the Starr Foundation to support ongoing and new programs.

The Dean's Office was pleased to welcome on board in February Professor Charles Stewart III as associate dean of SHASS with responsibility for undergraduate education and for strengthening activities across the social sciences. One of the leading experts on the American congress, Professor Stewart is the founding director of the Washington Summer Internship Program in the Department of Political Science. He is also a MacVicar Faculty Fellow and master of McCormick Hall.

The School continues to build and refine its undergraduate and graduate programs and to focus its efforts on fundraising, affirmative action and faculty recruitment in departments, sections and programs that are experiencing retirements and resignations. The faculty received a number of honors and awards, and some important administrative changes within the School have occurred.

Undergraduate Education

The School's participation in undergraduate education at the Institute is focused through its responsibility for the Humanities, Arts, and Social Sciences (HASS) requirement, which represents roughly half the course load embodied in the General Institute Requirements. All candidates for undergraduate degrees must pass eight HASS subjects, including three subjects in different HASS-Distribution categories, three subjects as part of a concentration in a field of HASS, and remaining HASS subjects that are elective.

The principal change in the undergraduate program during the 2001–2002 academic year was the implementation of the new undergraduate Communication Requirement. Overall responsibility for implementing the Communication Requirement rests with the Committee on the Undergraduate Program's Subcommittee on the Communication Requirement (SOCR). SOCR, in turn, has delegated to the Humanities Overview Committee (HOC) the responsibility for reviewing classes that will serve as CI-H. (Freshmen and sophomores are generally required to take one CI-H subject each year. Juniors and seniors generally take communication-intensive subjects in their chosen majors.)

As with last year, matters related to implementing the HASS portion of the Communication Requirement consumed considerable effort from faculty and administrative staff. The HOC, which has broad responsibility for undergraduate-education issues within the School, postponed for a second year the re-certification of continuing HASS-D subjects, for instance, to deal with the crush of business associated with certifying new CI-H. The HOC, chaired by Professor Peter Perdue, reviewed 16 proposals for new CI-H subjects, recommending 14 for CI status to the Committee on Curricula (COC). Taking into account last year's approvals and one withdrawn subject, we will have exactly 100 CI-H subjects available for the 2002–2003 academic year.

The biggest concern this year was ensuring that all students who needed to take a CI-H class could be accommodated. (A total of 3,026 enrollments were logged in CI-H subjects this year.) There has proved to be considerable leeway for enrollments to expand. In addition, the fact that so many CI-H subjects are also HASS-D subjects has meant that we have been able to use the HASS-D lottery system to distribute students into many CI-H subjects with a minimum of disruption.

However, the addition of a new category of Communication Intensive HASS subjects as part of the GIRs has put renewed pressure on the HASS-Distribution system. There are two reasons for this. The first is practical. Of the 60 CI-H subjects actually taught in 2001–2002, 25 were also

designated HASS-D. We have already observed some shifting of enrollments this year in favor of subjects that are both HASS-D and CI-H. This shifting of enrollments away from subjects that are "only" HASS-Distribution or HASS-Elective subjects will be a matter of attention within the School next year. The second reason is more substantive. The HASS-D requirement places practice in writing at the top of the goals pursued by these classes. The presence of a distinct Communication Requirement raises the question about whether the goals for HASS-D subjects are properly ordered. This, too, is a matter that will be addressed by the School next year.

In addition to beginning to implement the new Communication Requirement in earnest, associate dean Charles Stewart and Dr. Bette Davis, director of the HASS Office, have worked with officials from the Cambridge-MIT Institute undergraduate exchange program to encourage MIT students on exchange to take advantage of offerings in the humanities, arts, and social sciences at Cambridge. Because the Oxbridge system of higher education is so different from the American—especially in how it focuses on professional education at the expense of "elective" subjects—allowing MIT students at Cambridge to keep up with the HASS requirement during their exchange year has been a challenge. However, through the good will and hard work of officials at MIT and at Cambridge, a system has been arranged to facilitate the taking of HASS "papers" at Cambridge and transferring that credit to MIT fairly directly. Through meetings with students and the publication of a guide, "How to HASS@Cambridge," the School has begun advising Cambridge-bound MIT exchange students more systematically about the best way to approach HASS fields in Cambridge.

Affirmative Action

The total number of women faculty in SHASS had been steadily increasing for several years—from 35 women in AY1993 to a peak of 49 in AY2000. However, in the last two years, the numbers have dipped slightly—47 in AY2001 and 45 in AY2002. AY2003 will see yet another decrease with 44 women faculty in the School. With a current faculty of 150 in AY2002, women represent 30 percent of the total, and of these, 32 are tenured (31 percent of the tenured faculty). While we were successful in recruiting two new women to the faculty (1 tenured/1 untenured) for next academic year (2002-2003), we lost three junior women faculty, including one Hispanic American. On a more positive note, seven SHASS faculty were approved for tenure, including two women and two minorities (an African American woman and an Asian American man).

The School has had moderate success in its efforts to recruit minority faculty. Although we successfully recruited a Hispanic American man to join our faculty effective January 2003, a Hispanic American woman resigned her position effective June 2002 to enter the private sector. Therefore, the total number of minority faculty in the School—both this year and next—will remain at 21.

With the help of the Provost's Initiative and in keeping with the new Institute standards for faculty searches, we have asked the departments/sections/programs within SHASS to identify 5 to 10 leading senior (or tenurable at MIT) women and 5 to 10 leading senior (or tenurable at MIT) minorities in each field/discipline. We will then employ aggressive recruitment efforts to try and persuade those qualified women and minorities to come to MIT. In addition, we hope to establish an up-to-date database of women and minority graduate students across the country, thereby allowing us to develop a comprehensive candidate pool.

The School remains committed to increasing the minority representation of the administrative staff, as well as faculty, and happily announce that we successfully increased the number of minorities among the administrative staff from the previous year's total of three to this year's four. We now have four minorities (one Hispanic and three Asian Americans) among the 38 members of administrative staff in the School (approximately 11%). We hope to further diversify our administrative staff by working closely with the departments and programs in the School and with the Office of Human Resources.

Honors and Awards

The faculty within the School garnered an array of honors and awards this year. The most notable among them were the following:

Associate professor of Chinese Studies Emma Teng was named The Class of 1956 Career Development Professor.

Associate professor of political science Chappell Lawson was named The Class of 1954 Career Development Professor.

Associate professor of literature Diana Henderson was awarded the 2002 Levitan Prize in the Humanities.

Professor of literature David Thorburn was appointed a Margaret MacVicar Faculty Fellow.

Professor of political science Stephen D. Ansolabehere, along with Arthur and Ruth Sloan professor of political science and economics James M. Snyder, Jr. and associate dean Charles Stewart III, were recipients of the Jewell-Loehenberg Award for the Legislative Studies Section of the American Political Science Association.

Professor of economics Abhijit Banerjee was awarded the Mahalanobis Memorial Medal 2000.

Olivier Blanchard, Class of 1941 professor of economics, was elected to the Econometric Society Council.

Institute Professor of linguistics Noam Chomsky was awarded the Rabindranath Tagore Centenary Award from the Asiatic Society, Calcutta.

Ricardo Caballero, Ford international professor of economics, received the 2002 Frisch Medal of the Econometric Society.

Joshua Cohen, Leon and Anne Goldberg professor of humanities and professor of philosophy, and Philip S. Khoury, Kenan Sahin dean and professor of history, were elected fellows of the American Academy of Arts and Sciences.

Professor of history and urban studies Robert Fogelson was awarded the Lewis Mumford Prize for his book Downtown: Its Rise and Fall, 1880–1950.

Professor of the history of science Evelynn M. Hammonds was named the Sigma Xi Distinguished Lecturer for 2003-2005 and was inducted into the Phi Beta Kappa chapter at Spelman College.

Paul L. Joskow, Elizabeth and James Killian professor of economics and management, was awarded the Undergraduate Economics Association teaching award from MIT.

Professor of history and philosophy of science Evelyn Fox Keller was presented with the medal of the Italian Senate in recognition of her outstanding contribution to research.

David A. Mindell, Frances and David Dibner associate professor of the history of engineering and manufacturing, was awarded the Society for the History of Technology's (SHOT) IEEE Life Member Prize in electrical history. He also received SHOT's Sally Hacker Prize.

Associate professor of literature Shankar Raman was given the Jeptha H. and Emily V. Wade Award.

Professor of music Evan Ziporyn received an American Society of Composers, Author and Publishers Award.

Fundraising

New gifts and pledges for FY2002 total $19,451,005. With the $75 Million from the Kenan Sahin gift, the campaign total for SHASS (July 1, 1997 through June 30, 2002) is $129,938,814.

Fundraising Highlights

- The French Ministry of Foreign Affairs committed $1 million for the MIT International Science and Technology Initiatives (MISTI) Program within the Center for International Studies (CIS) on the condition that MIT raise $1 million for the same purpose. As of June 2002, MIT completed the match to qualify for the full $1 million.
- The Barker Foundation committed $1.25 million for the support of the MIT Communication Requirement.
- A pledge of $50,000 for the Washington Summer Internship Program from Richard B. Levin '72 PO and support of $75,000 for the Political Science Department from Conor D. Reilly '72 PO.
- John S., '71, and Cynthia Reed established the French Initiatives Fund within the Foreign Languages and Literatures Section with a commitment of $725,000 and an additional gift of $200,000 for MIT France.
- $1 million pledge from Gerald L. Katell '62 to the Comparative Media Studies Program (CMS) endowment.
- $1 million commitment from Anthony Sun '73 to support and enhance the MIT International Science and Technology Initiatives (MISTI) Program.
- James Y. Chao '71 added $748,000 to the T. T. and Wei Fong Chao Professorship in Asian Civilizations currently held by Professor Peter Perdue on the History Faculty.

SHASS Fundraising Priorities

The top School fundraising priorities continue to be increased support for graduate fellowships (Economics, Political Science, Linguistics & Philosophy, and the Program in Science, Technology and Society), and professorships at all levels.

Specific program priorities include the Shakespeare Archive, Chinese Language and Culture Program, Comparative Media Studies, Bilingual/Bicultural Studies, Linguistics (Endangered Languages Program), Writing and Humanistic Studies (especially the new Masters Program in Science Writing), the Center for International Studies (CIS), along with the individual MISTI programs within CIS, and the Knight Science Journalism Program.

Faculty Promotions, Administrative Changes, Retirements

This year has seen two retirements, eight resignations and eight new faculty appointments within the School. Among the faculty retirements were Institute Professor Noam Chomsky (Linguistics & Philosophy) and Professor Arthur Steinberg (Anthropology). Among the resignations were four associate professors (all non-tenured), and four assistant professors.

A total of seven faculty members in the School were promoted to tenure this year, effective July 1, 2002: Alexander Byrne of the Department of Linguistics & Philosophy, Esther Duflo and Jaume Ventura of the Department of Economics, Melissa Nobles of the Department of Political Science, David Mindell of the Program in Science, Technology and Society, Shankar Raman of the Literature Section, and Jeffrey Ravel of the History Faculty.

The School was successful in recruiting a total of eight new members to the faculty for AY2003. Of the eight, one will join the faculty as a full tenured professor (Donca Steriade to the Department of Linguistics & Philosophy); one as a non-tenured associate professor (Junot Diaz to the Program in Writing & Humanistic Studies); and six as assistant professors in Economics, Foreign Languages & Literatures, History, and Music & Theater Arts.

Philip S. Khoury
Kenan Sahin Dean, School of Humanities, Arts, and Social Sciences
Professor of History

More information about the School of Humanities, Arts, and Social Sciences can be found on the web at http://web.mit.edu/shass/.

Humanities, Arts, and Social Sciences Office

This year the HASS Office welcomed a new staff member, Susan Stapleton, administrative assistant. Susan has done a yeoman's job of learning the many and varied tasks connected with this position.

The new Communication Requirement was implemented this fall. HASS Communication Intensive subjects (HASS CIs, including CI-H and CI-HW classes) again consumed much of the time and attention of the HASS Overview Committee (HOC), to which the HASS Office provides all administrative and clerical support. The director of the HASS Office, Dr. Bette Davis, serves as ex officio member of the HOC. The administrative assistant, Susan Stapleton, maintains the web list of HASS CI subjects and the HASS CI database. That database was further refined this year, to enable it to hold more detailed information. The HASS CI database is one of five databases that this small office maintains; others are the HASS Minor, Course 21 majors, Harvard Cross-Registration, and mailing-list databases. The normal work of the office has continued, of course, including producing the HASS Guide each term, handling HASS concentrations and minors, the Harvard Cross-Registration Program, and compiling various statistics for the dean.

Bette Davis has also been involved with the undergraduate exchange component of CMI, the Cambridge MIT Institute—specifically, helping to facilitate MIT students' receiving HASS credit for papers done at Cambridge. As part of this effort, she traveled to Cambridge in late November.

HASS Enrollment Statistics by Field and Subject—Recent Trends

Total enrollments in all HASS subjects were down very slightly—from 9,828 a year ago to 9,804. This was the case despite the fact that more HASS subjects were offered—474, compared to 466 in 2000-2001. The number of autonomous sections was almost exactly the same—600 for AY2002 and 598 in AY2001. The number of HASS-D subjects taught was down very slightly—112, compared to 117 last year. The two fields with the largest overall enrollments were the same as last year, in the same order: 1,604 in Economics (down from 1,803 last year) and 1,532 in Foreign Languages and Literatures (up slightly from last year's 1,515). Fields with the third and fourth highest enrollments also remained the same: Literature (985) and Writing (923). These were followed by Music (683*), and Philosophy (627). (*Six-unit music-performance subjects are not included in these statistics.) Among the various disciplines in HASS, there was a considerable range—from experiencing a significant drop in enrollments, to remaining stable, to those fields that saw a significant increase. Anthropology and Urban Studies tied for the largest increase over last year in terms of percentage (27 percent—from 321 to 409, and from 187 to 238, respectively). These were followed by Linguistics and STS, also tied (19 percent—from 123 to 146 and from 199 to 237, respectively.) The next highest increases in enrollment, in terms of percentage, were in Political Science (10 percent) and Philosophy (8 percent).

HASS Concentrations: Patterns of Popularity

In AY2002, students submitted 2,090 HASS Concentration proposals and 1,184 completion forms, compared to 2,184 proposals and 1,183 completion forms last year. Once again, Economics and Foreign Languages led in the number of completed HASS Concentrations: in AY2002, 337 students (compared to 341 last year) completed concentrations in Economics, and 214 completed concentrations in Foreign Languages & Literatures, compared to 213 last year. (For a breakdown by languages, see Table II.) The next two most popular HASS Concentration fields are Music, with 98 completed concentrations, and Writing, with 68, followed by Literature (59), Political Science (47), and Psychology (43).

HASS Minor Programs

AY2002 showed an increase in the total number of HASS Minor applications from all graduating classes—445, compared to 439 last year. The number of HASS Minors received by the Class of 2002 was also up— 217, compared to 173 last year. The two most popular fields in terms of applications filed were the same as last year: Economics (196) and Music (42). There were 29 minors in Writing; 27 in Political Science; 26 in Foreign Languages (3 in French, 8 in German, and 15 in Spanish), and 25 in Literature. The 217 HASS Minors received by the Class of 2002 were in 23 fields.

Harvard Cross-Registration

The number of MIT undergraduates cross-registered for courses at Harvard decreased in AY2002. Two hundred thirty-five students took 251 subjects at Harvard, compared to 246 students enrolled in 290 subjects in AY2001. Last year there was a sizable increase in these enrollments; the previous year there had been a decrease—they seem to fluctuate for no obvious reason. As usual, foreign languages were by far the most popular field of study. 142 of the 251 subjects were in 21 different foreign languages. The most popular language was Italian (21). It was followed by Korean (18), Urdu-Hindi (16), Arabic (15), and Chinese (13). Enrollments in other languages ranged from one to nine. The most popular field outside foreign languages was economics (20). Following economics, other popular fields were English (10); classics and art/visual studies, each with 7; and religion (6).

Undergraduate Degrees Granted in SHASS

Eighty-five students received the S.B. in SHASS this year, down from 89 last year. Of these, 46 degrees were in Economics (Course 14) and 8 were in Political Science (Course 17). During the same time period, September 2001 through June 2002, a total of 27 students completed the S.B. Degree in Humanities (Course 21). Eight of these received joint degrees, 5 in 21-E and 3 in 21-S. Another 13 received degrees in a specified field within Course 21. One student received the S.B. in Philosophy and three received the S.B. in Linguistics and Philosophy (Course 24).

Undergraduate Majors in SHASS

The four departments in SHASS had 133 undergraduate majors this year; this figure includes only first degrees. Eighty-two of these are majoring in Economics, and the Political Science Department had 17 majors. Twenty-six students had a Humanities major as their first degree inAY2002; of these, 7 were joint majors (5 in 21-E and 2 in 21-S.) Of the specified majors within Humanities, Literature and Writing had the most majors, with 5 each. Eight undergraduates had a first degree in Philosophy or in Linguistics and Philosophy.

Honors and Awards Granted to Undergraduate Majors In SHASS

Among the more notable honors achieved by SHASS majors this year were:

John L. Asinari Award: Tara Mullaney, '02

The Boit Manuscript Prize: First Place Poetry, Moana Minton '02

Robert A. Boit Writing Prize: First Place Short Story and Honorable Mention Essay, Jovonne Bickerstaff '02; Second Place Poetry, Allison Lewis, '04; Honorable Mention Short Story, James Dillon III '04

Burchard Scholars: Jeremy Baskin '04, Monami Chakrabarti '03, Guan-Jong Chen '04, Rebecca Clinton '03, Roy Esaki '04, Antimony Gerhardt '03, Annemarie Grandke '04, Ruimin He '04, Daniar Hussain '04, Shaheer Hussam '03, Tiffany Kanaga '04, Timothy Kreider '04, Martin Kurtev '04, Veronica Lois '03, Katrina Lust '03, Erin Mellencamp '03, Megha Padi '03, Alexander Phillips '03, Margeaux Randolph '04, Nirupama Rao '04, Mikael Rechtsman '03, Raymond Sandza '03, Rahul Sarathy '03, Josiah Seale '03, James Skelley '04, Christopher Taylor '04, and Natalia Toro '03

2002-03 Ronald H. Cordover Scholar: David Foxe '03

DeWitt Wallace Prize for Science Writing for the Public: First Place, Winnie Yang '02

Peter J. Eloranta Fellowship: Lianne Habinek '02; Joyce W. Lee '02

Louis Kampf Writing Prize: Honorable Mention, Winnie Yang '02

I. Austin Kelly III Essay Prizes: Joyce W. Lee '02

Ronald E. McNair Scholarship Award: Melissa Edoh '02

The Merck Index Award: Alexandra G. Ianculescu '02

Assoc. of MIT Alumnae Senior Academic Award: Alexandra G. Ianculescu '02

Phi Beta Kappa: Lianne A. Habinek '02, Jessica A. Hall '02, Radha K. Iyengar '02, Maria S. Jelescu '02, Brian A. Pasquinelli '02, Senkodan Thevendran '02, Daniel L. Tortorice '02, Patricia Young '02

Outstanding Political Science Undergraduate Theses: Victoria Anderson '02, and Alexander Tahk '02

Program on Human Rights and Justice Summer Internship Award: Jovonne Bickerstaff '02

William L. Stewart J. Award: Jovonne J. Bickerstaff '02

Gregory Tucker Memorial Prize: David Foxe '03; Mary Tsien '02

The Laya Weisner Community Award: Effrat Shavit '02

The Laya W. Weisner Award: Radha K. Iyengar '02

Prize for Writing Science Fiction: Second Place, Jovan Hsu '03; Honorable Mention, Kristopher Schnee '02

Bette Davis
Director

More information about the Humanities, Arts, and Social Sciences Office can be found on the web at http://web.mit.edu/hass/www/.

Anthropology

The Anthropology Program is dedicated to advanced research and publication in cultural anthropology; to undergraduate teaching that opens students to the fundamentals of cross-cultural understanding and social thought; and to graduate teaching in the history and social study of science and technology. Our undergraduate subjects cover a wide range, with special strengths in the study of the contemporary world and the social context of technology. The anthropology faculty maintains strong ties with other programs in the School of Engineering and the School of Humanities, Arts, and Social Sciences, including Women's Studies, Latin American Studies, Comparative Media Studies, the Technology Policy Program, the History Faculty, and Science, Technology, and Society.

Personnel and Administrative Changes

AY2002 began with the Anthropology Program reorganized and administratively separated from the Science, Technology, and Society Program, with Professor Susan Slyomovics continuing as head of the Anthropology Program and Rosemary Hegg serving as administrative officer. Susan LoGuidice joined the program as administrative assistant.

On July 1, Susan Silbey, formerly professor of sociology at Wellesley College, joined the MIT Anthropology Program at the rank of full professor. The end of the year saw the retirement after 38 years of service to MIT of Professor Arthur Steinberg. An appreciation event with speeches by students and colleagues was held in his honor in April. A search has begun to find a junior faculty member who would begin in July 2003. In June of 2002, Professor Slyomovics completed her term as head of the Anthropology Program. She will be succeeded by Professors Jean Jackson (fall term) and James Howe (spring term).

Program Contributions to MIT and Outside Communities

The committees, boards, and task forces at MIT on which Anthropology Program members served this year include the Women's Studies steering and programming committees, Kelly-Douglas Prize jury, the Knight Fellowship selection committee, the Louis Kampf Writing Prize jury, the Advisory Board Program in Human Rights and Justice, the editorial board of the MIT Faculty Newsletter, the admissions and curriculum committees for CMS, the Committee on Academic Performance, and the steering committee of the doctoral program in the History and Social Study of Science and Technology (HSSST). Professor Jackson chaired the SHASS Gender Equity Committee.

Professors Michael Fischer, Jackson, Howe, and Silbey, and associate professor Hugh Gusterson all play active roles in teaching, advising, and administration of the HSSST doctoral program, sponsored by the STS, History, and Anthropology programs. Professor Steinberg continued as director of the Integrated Studies Program until his retirement at the end of the year.

Outside MIT, Professor Slyomovics serves on four boards. Professor Gusterson was the program chair of the Society for Social Studies of Science (4S) Meeting, treasurer for the American Ethnological Society, and served on several committees for the National Science Foundation. Professor Silbey was appointed to the editorial board of the American Journal of Sociology. Professor Jackson continues to serve on the advisory board of Cultural Survival and the editorial board of the Journal of Latin American Anthropology.

Educational Activities

Anthropology classes continued to be popular among undergraduates. Thirty students in the class of 2002 completed HASS concentrations in anthropology. One student majored and three completed minors in anthropology. Course 21A (Anthropology) introduced two new subjects during AY2002, 21A.218 Identity and Difference and 21A.219 Law and Society, both taught by Professor Silbey. Law and Society was particularly well subscribed with 40 students completing the class. 21A.230 Contemporary American Family continued to be a popular choice with 40 enrollments, as did 21A.100 Introduction to Anthropology with 73 students. 21A.344 Drugs, Politics, and Culture enrolled 75 students.

Presentations

A small sampling of presentations by members of the Anthropology Program faculty during AY2002 gives some sense of the wide range of their research interests, as well as their shared viewpoint and focus. In April 2002, Professor Slyomovics gave a talk entitled "Prison Space in Morocco" at the Society of Architectural Historians Annual Meeting, in Richmond, Virginia. In addition to several talks at MIT and elsewhere, Professor Jackson gave a talk entitled "What the Hell Did I Do to Deserve This? Chronic Pain Sufferers' Search for Answers" at the American Anthropological Association (AAA) Meeting in Washington, DC, November 2001. Assistant professor Christine Walley's paper "'Our Ancestors Used to Bury Their Development in the Ground': Modernity and Meaning of Development within the Mafia Island Marine Park" was read in absentia at the Fifth Anglo-French Swahili Workshop, at the School of Oriental and African Studies, in London, September 2001. Assistant professor Walley gave a talk entitled "Sisi Tusiosoma ('We, the Uneducated'): Post-Socialism and the Language of Class in

Mafia, Tanzania" and was co-organizer of a panel entitled "Socialisms/Post-Socialisms: From the Margins" at the AAA Meeting in Washington, DC. Professor Fischer served on several panels and gave a presentation entitled "Science and Ethics in Biological Research—Research Integrity, Education, and Environmental Issues" to the National Academy of Sciences of Iran and US National Academies of Science, Engineering and Institute of Medicine, in Bellagio, April 2002. Professor Silbey's numerous presentations at colloquia and conferences have included presentations at the Yale Women Faculty Forum and New York Law School. She also gave a talk entitled "Resistance and Narrative" at the Law and Society Annual Meeting, in Budapest, July 2001.

Publications

Professor Slyomovics's edited volume *The Walled Arab City in Literature, Architecture and History* was published by Frank Cass, in London, in fall 2001. Her article "Torture, Truth and Recovery in Morocco" was published in *Experiments with Truth: Transitional Justice and the Processes of Truth and Reconciliation*. Documenta 11," 2002. Professor Slyomovics also completed two translations.

Professor Jackson has a co-edited volume and five chapters and reviews in press.

Professor Silbey's articles included "Mutual Engagement: Sociology of Law and Criminology in Law, Crime and Social Change, 2001.

In the past year, Professor Gusterson published the articles "The McNamara Complex" in *Anthropological Quarterly*, "Elites: Anthropology of" in The International Encyclopedia of the Social and Behavioral Sciences, "An Hour with Noam Chomsky" in *Interventions*, and "Tall Tales and Deceptive Discourses" in *The Bulletin of the Atomic Scientists*.

AY2002 saw three publications by Professor Fischer with one in press.

Professor Walley's article "Searching for 'Voices': Feminism, Anthropology and the Global Debates over Female Genital Operations" appeared in *Genital Cutting and Transnational Sisterhood: Disputing U.S. Polemics*, edited by James and Robertson, University of Illinois Press, 2002.

Other Program Accomplishments

Professor Walley, who was on leave during 2001-2002, is co-director and producer of "Exit Zero", a documentary, presently a work-in-progress, about a changing working class neighborhood on Chicago's Southeast side.

Professor Howe, who was on leave during the spring semester, has been involved in the study of indigenous scribes and their collaboration with outsiders to represent their society to the world. Professor Howe's project in collaboration with Kuna General Congress to microfilm a tribal archive is in its final stages.

Grants, Honors, Awards

Professor Howe received a Wenner-Gren Foundation grant in support of ethnohistorical research. Professor Slyomovics was elected a fellow of the American Folklore Society.

Susan Slyomovics
Program Head
Professor of Anthropology

More information on the Anthropology Program can be found on the web at http://web.mit.edu/anthropology/.

Comparative Media Studies

Established as a graduate program in 1999-2000, Comparative Media Studies aims to integrate the study of contemporary media (film, television, digital systems) with a broad historical understanding of older forms of human expression. The program embraces theoretical and interpretive principles drawn from the central humanistic disciplines of literary study, history, anthropology, art history and film studies, and aims as well for a comparative synthesis that is responsive to the distinctive emerging media culture of the 21st century. Students in the program are taught to explore the complexity of our media environment by learning to think across media and to see beyond the boundaries imposed by older medium-specific approaches to the study of audio-visual and literary forms.

The comparative and cross-disciplinary nature of both the graduate and undergraduate programs is embodied in a faculty drawn from Art and Architecture, Anthropology, Foreign Languages and Literatures, History, Literature, Music and Theater Arts, Philosophy, Writing and Humanistic Studies, Science Technology and Society, Media Arts and Sciences, and Political Science. Approximately 35 faculty members teach subjects in Comparative Media Studies.

The graduate program consists of a two-year course of study leading to a Master of Science degree. The program aims to prepare students for careers in fields such as journalism, teaching and research, government or public service, museum work, information science, corporate consulting, media industry marketing and management, and educational technology. Recent graduates are now employed by media and technology consulting firms, media production companies, and other colleges and universities. Four alumnae are pursuing advanced degrees at New York University, the University of California at Los Angeles, and at MIT, where two have been accepted to the doctoral program in Science, Technology, and Society.

Research

Themes

CMS research themes cross academic disciplines and involve both traditional and emerging communications media, establishing a focus for public presentations, research agendas, and curricular initiatives. The primary research themes are Creativity and Communication in an Interactive Age; Generation.org–Childhood and Adolescence in a Hyper-mediated Culture; Informed Citizenship and the Culture of Democracy; Global Culture and Media; Media in Transition; and Transforming Humanities Education.

In 2001-2002, CMS ran three lab groups (Creativity and Communication in a Digital Age; Global Culture and Media; and Transforming Humanities Education) which met weekly and involved the graduate research assistants. CMS faculty, research staff, and visiting scholars, as well as other professionals and collaborators, led weekly discussions around both relevant theoretical scholarship in each area and how such ideas could be applied to the project-specific work being pursued by each group.

Projects

The iCampus Games-to-Teach Project, run in partnership with the Learning Sciences and Technologies Group of Microsoft Research, focused on the interactive, immersive, and narrative potential of digital games as an educational medium. Over the past year, CMS explored a variety of new pedagogical models using games and applied these models to a series of conceptual game prototypes designed to support advanced high school and first-year college science and engineering curricula. This coming year, CMS will develop a smaller set of working prototypes to use and assess in MIT curricula during spring 2003; the project will also extend conceptual development to include prototypes in the humanities and social sciences.

The MetaMedia Archive Project, funded by the D'Arbeloff Award for Excellence in Education, began development of interactive archive models for use across a broader range of topics in the humanities and social sciences; early projects included work in Shakespeare, Melville, and German and Spanish language and culture. Intended to serve as modules that teachers and students could use to explore rich subject areas, create rhetorical multi-media documents, and collaborate over the internet, early MetaMedia Archives have stretched instructors' and students' notions of textbook, research paper, and classroom. Development continues on additional mini-archives through the coming year, including projects on oral history, early comic strips, and dance.

As part of the Electronic Arts Creative Leaders Workshops, CMS faculty conducted seminars for producers and other creative developers at Electronic Arts. These seminars afford discussion around basic concepts for thinking about the interplay between character, plot, and emotion, drawing examples from both traditional arts (literature, theater, cinema, television, opera) and from contemporary computer and video games.

In September 2001, a volunteer group of CMS faculty and students conceived and launched a web site for teachers and students to "reflect on humanity and media after tragedy." *Re:constructions* was launched within a week of the terrorist attacks of 11 September and provided a place where visitors could find essays, resources, and lessons to help them better understand some of what they saw, heard, or experienced through various media and in cultural and social spaces. The URL for the site is: http://web.mit.edu/cms/reconstructions/.

CMS is also pursuing a variety of additional research efforts and projects with a diverse set of collaborators, including the MIT Media Lab, MIT's Initiative on Technology and Self, American Federation of Scientists, Beijing Film Academy, Royal Shakespeare Company, Public Radio International, Stanford Medical School, and CMS Research Consortium members, including HopeLab and Initiative Media.

Fundraising

Development activities have yielded several major new and continuing sponsored research projects, as well as new members to the MIT Research Consortium in Comparative Media Studies. A continued goal of activities this past year was to develop and implement sustainable and scalable business, teaching, and research models within which faculty and graduate students could explore interdisciplinary research themes and educational priorities. As it continues to solidify administrative and academic infrastructures, CMS has begun to focus on cultivating a broader range of sponsored research and gifts from corporations, individuals, and foundations.

Gerald Katell, an MIT alumnus and CMS Advisory Group member, pledged $1 million to endow the Gerald L. Katell (1962) Endowed Fellowship and Education Fund in Comparative Media Studies; over time, the fund will provide valuable fellowship support for graduate students, as well as discretionary funds for educational programs.

Governance

Professor Henry Jenkins is the director of Comparative Media Studies. Professor William Uricchio is associate director. The program is under the auspices of three Humanities sections—Literature, Writing and Humanistic Studies, and Foreign Languages and Literatures. Administratively, CMS is housed in the Literature Section.

The program is governed by a steering committee, chaired by Professor Jenkins. Steering committee members for 2001-2002 were Professor Uricchio; Professor Peter S. Donaldson, head of Literature; Professor James Paradis, head of Writing and Humanistic Studies; Professor of literature David Thorburn; senior lecturer in writing and humanistic studies Edward Barrett; and senior lecturer in music and theater arts Martin Marks.

During 2001-2002, Comparative Media Studies had three active committees, besides the steering committee: the curriculum committee, chaired by senior lecturer Marks; the admissions committee, chaired by Professor Diana Henderson; and the orientation committee, chaired by associate professor Christina Klein.

Admissions

For the second year, CMS has been operating at its target population of 20 students in residence. Our current cohort includes 14 women, and 10 international students from countries including Bulgaria, Singapore, the Czech Republic, India, the People's Republic of China, Norway, and the United Kingdom. For fall 2002 we admitted 10 students from 100 applicants; all accepted, but one later declined admission for personal reasons.

The program hosted a series of on-campus Information Sessions, designed to allow potential students to meet CMS faculty and students and evaluate opportunities through the program, and to sit in on classes and research meetings. CMS also conducted online chat sessions to facilitate interaction with potential applicants who could not attend these on-campus sessions; on-line sessions were particularly popular with a growing number of international applicants.

Undergraduate Education

The undergraduate program—established in 1982 under its former name, Film & Media Studies—serves as preparation for advanced study in a range of scholarly and professional disciplines and also for careers in media or industry. The curriculum consists of more than 50 subjects arranged in three tiers and broadly subdivided into three areas or fields: comparative media, film, and digital studies. Concentrators, minors, joint-majors and majors may specialize in one of these areas or map a coherent combination of subjects across these borders.

CMS is in the process of applying for full undergraduate major status. So far, the proposal has been approved by the Committee on the Undergraduate Program and is under consideration by the Committee on Curricula. If approved, CMS will become the first interdisciplinary undergraduate major at the Institute.

CMS has also developed educational and research programs to provide additional opportunities for undergraduates to gain both academic and professional experience in media-related fields. In January, CMS annually coordinates a weeklong IAP event, "Adapting Linear Storytelling in an Interactive Age," with Sony Pictures Imageworks.

In 2001-2002, Comparative Media Studies hired 25 UROPs for pay and credit. This record number of UROPs reflects the great increase in research activity in the program. Over the summer, we have four UROPs working on the Games-to-Teach Project, including one from the United Kingdom sponsored by the Cambridge-MIT Initiative.

Current undergraduate student enrollments for the academic years 2001-2004 stand at 13 majors, 17 minors, and 49 concentrators. The undergraduate homepage is http://web.mit.edu/21fms/www/.

Events and Programs

Conferences

In May 2002, CMS hosted its second Media in Transition conference around the theme of media, globalization, and convergence. More than 130 papers were presented by international scholars on such diverse topics as "The Cultural Politics of Pokemon Capitalism," "Indian Television and Diasopric Identity," "Internet, Identity Politics, and the Making of Counter Media Culture in Taiwan," and "Hollywood as an Instrument of European Integration." The conference focused on North American, European, and Asian experiences, and provided a platform for a historically and culturally comparative analysis of our media past, present, and future. The conference was held in conjunction with the tele-journeys exhibit at the List Visual Arts Center, and featured a special performance by MIT students, *BollySpace: An Interactive Dance Technology Project*, funded by the MIT Office of the Arts. Papers and audio recordings of the plenary sessions can be found on the conference web site at http://cms.mit.edu/mit2/.

Communications Forum

Directed by Professor Thorburn, the Communications Forum sponsors lectures, panel discussions, and conferences on all aspects of technology and communications, public policy, and media in transition. The Communications Forum sponsored several panel discussions that attracted a large audience from the academic community at MIT and in the Boston area. Topics included "Religion and the Internet," "World Media and Monopolies," Teen Activism on the Web," and "Transformations of the Book."

Colloquia

CMS sponsored weekly colloquia designed to give our graduate students, and the academic community at MIT, a rich and challenging intellectual experience, and opportunities to interact educationally and socially. Topics included "Re-play: Televised Sports and Cultural Change" (Bo Reimer); "Blaxploitation Cinema" (Isaac Julien); "Digital Arts in Boston: 'A Public Cyberdock' and 'A Chinatown Banquet' " (Liz Canner and Mike Blockstein); and "Utopian Entrepreneur" (Brenda Laurel).

Honors and Awards

Several faculty members affiliated with CMS received awards. Professor Irving Singer was a fellow of the European Humanities Research Centre at Oxford University, England. Professor Susan Slyomovics was elected a fellow in the American Folklore Society. Senior lecturer Barrett received a Massachusetts Cultural Council Grant for Poetry. Professor Thorburn received a Margaret MacVicar Faculty Fellowship. Associate professor Chappell Lawson was awarded the Hoover National Fellowship from the Hoover Institution, Stanford University. Professor Henderson received the Levitan Prize in the Humanities.

Student awards include the following: Nadya Direkova received an Amherst College Alumni Graduate Studies Fellowship, as well as a grant from the Council of the Arts for a photography project. Aswin Punathambekar, Sangita Shreshtova, and Zhan Li received funding from the MIT Council for the Arts for their multimedia performance *BollySpace: An Interactive Dance Technology Project*.

The Comparative Media Studies Administrative, Development and Support Staff Team received the 2001 MIT Excellence Award in the category "Building Bridges"; and senior editorial assistant Robert Bain Jr. earned the Positive Energy award in the School of Humanities, Arts, and Social Sciences, as part of MIT's Rewards and Recognitions Program.

Publications

Professor Singer's book *Explorations in Love and Sex* was published by Rowman & Littlefield Publishers; Professor Singer also contributed the article "The Morality of Sex: Contra Kant" in *The Philosophy of Sex: Contemporary Readings*, edited by Alan Soble (Rowman & Littlefield). Professor Slyomovics' *The Living Medina in the Maghrib: The Walled Arab City in Literature, Architecture, and History* was published by Frank Cass Publishers. Senior lecturer Barrett was co-author of *The MIT Guide to Teaching Web Site Design* (MIT Press), and wrote a book of poetry, *Sheepshead Bay* (Zoland Books).

Professor Edward Baron Turk's *Marcel Carné et l'Age d'or du Cinema Français* appeared in its first French edition, from L'Harmattan, translated by renowned film theorist Noel Burch. Professor Jing Wang edited a special issue of the journal *positions: east asia cultures critique* which focused on Chinese popular culture and the state. Professor Lawson's book *Building the Fourth Estate: Democratization and the Rise of a Free Press in Mexico* was published by University of California Press.

Professor Jenkins continued to write a monthly column on media and cultural change for *Technology Review* magazine and published three new essays in academic books: "Tales of Manhattan: Mapping the Urban Imagination through Hollywood Film," in *Imaging the City: Continuing Struggles and New Directions*, edited by Lawrence Vale and Sam Bass Warner (CUPR Press); "The Art of Contested Spaces" (with Kurt Squire), in *Game On*, edited by Lucian King (Barbican); and "I'm Gonna Get Medieval on Your Ass!: A Dialogue about Violence and Culture" (with associate professor James Cain), in *The Culture of Violence*, edited by Helaine Posner (University of Massachusetts Art Museum).

Administrative Note

Robert Bain Jr. is leaving his position as senior editorial assistant for a terrific reason: he will be starting as a graduate student in CMS this fall! The job has been expanded into a full-time administrative assistant position; Susan Stapleton was hired for this job.

Information

For more information on the undergraduate and graduate programs in Comparative Media Studies, contact the CMS Office, 14N-207, MIT, Cambridge MA 02139; telephone 617-253-3599; fax 617-258-5133; email cms@mit.edu.

Henry Jenkins
Director
Anne Fetter Friedlander Professor of Humanities
Professor of Literature and Comparative Media Studies

The Comparative Media Studies web site is http://web.mit.edu/cms/.

Department of Economics

We are currently ranked as the best economics department in the world. Our goal is to make sure we stay there.

Highlights of the Year

Two department graduates received important honors. Joseph Stiglitz (PhD 1967) and George Akerlof (PhD 1966) were co-recipients of The Bank of Sweden Prize in Economic Sciences in Memory of Alfred Nobel for 2001, along with A. Michael Spence. The Nobel Prize was awarded to them for their analyses of markets with asymmetric information.

A number of faculty members also received important honors and awards. Professor Peter Temin received a Guggenheim Fellowship. Assistant professor Esther Duflo received a Sloan Foundation Research Fellowship for 2002-2003. Assistant professor Sendhil Mullainathan received an Olin Faculty Fellowship for 2002-2003. Assistant professor Xavier Gabaix received a Russell Sage Foundation Fellowship for 2002-2003.

Professor Abhijit Banerjee is the co-winner of the Mahalanobis Memorial Medal for 2000 from The Indian Econometric Society, along with Alan Krueger of Princeton University. This prestigious award is presented for "outstanding contributions to quantitative economics." It is given once every five years.

Professor Ricardo Caballero was co-recipient with Eduardo Engel of the 2002 Frisch Medal of the Econometric Society for their paper "Explaining Investment Dynamics in US Manufacturing: A Generalized (S,s) Approach." The Frisch Medal was established by the Econometric Society to encourage the creation of good applied work and its submission to the journal *Econometrica*. It is given every two years for an applied article (empirical or theoretical) published in *Econometrica* during the past five years.

Professor Rudiger Dornbusch was awarded the Perkins Award for Excellence in Graduate Advising by MIT. The Frank E. Perkins Award was created on the occasion of Dr. Perkins's retirement from the position of dean of the graduate school (1983-1995). The award is presented to a faculty member who, as a graduate student advisor, demonstrates unbounded compassion and dedication towards students.

A number of faculty members serve in leadership positions in various economics associations. Institute Professor Peter Diamond is the president-elect of the American Economic Association, and Professor James Poterba is a member of the executive committee. Professor Olivier Blanchard is on the Council of the Econometric Society. Professor Temin is the president of the Eastern Economic Association.

Turning to students, graduate and undergraduate:

Dr. David Finch gave the department an additional contribution to the David Finch Fellowship Fund, allowing the department to award it two out of every three years.

Next year's entering class of 23 PhD students will include 14 international students and 7 women (30 percent). Seven members of our entering class have won National Science Foundation Fellowships.

Undergraduate enrollment decreased this year by 9 percent. This is a dip on an overall positive trend in enrollment. Taking a longer view, the increase has been nearly 20 percent over the last fifteen years.

There were 109 undergraduate majors in economics (27 of whom are double majors), 196 undergraduate minors, and 337 concentrations completed in economics. 46 students received their S.B. in economics in 2002.

Our graduate students on the job market did well this year, with 41 percent receiving assistant professorships in the top 20 economics departments and business schools. A total of 65 percent accepted academic positions, 23 percent took positions in government, and 12 percent obtained positions in the private sector.

The World Economy Laboratory (WEL), directed by Professor Dornbusch, continued to provide resources for the department. Two WEL conferences were held in Washington, DC during the academic year.

Future Plans

Our department is doing very well. The atmosphere is warm and friendly, the research atmosphere is exciting, and faculty members are productive. Our junior faculty are particularly outstanding, and we see this as our main strength for the future. Some fields where we were less strong—labor economics and development, in particular—are expanding and attracting an increasing number of students. A new field, behavioral economics, is becoming increasingly popular.

We feel we still have two major senior needs, one in theory and one in macroeconomics. We had two search committees looking at potential candidates. We made an offer in theory to Ilya Segal; the offer is still outstanding.

Competition from other departments is becoming more intense, and our few competitors are often bigger and richer. We strongly feel that, to thrive in the long run, the department must increase in size, both by expanding its core, and the number of faculty members in major fields. We made the case to the visiting committee last spring, and later to the senior administration. We are happy with their response, and intend to fill the new positions given to the department over the coming three years. We also have to secure one of our main assets, the quality of our student pool, by increasing the number of fellowships we can offer.

This is all the more urgent, given the decline in many of the traditional external sources of such fellowships.

Personnel

Professor Robert Gibbons of the Sloan School was given a joint appointment in the department. Associate professor Jaume Ventura was awarded tenure. Professor Duflo was promoted to associate professor with tenure. Professor Mullainathan was promoted to associate professor. Assistant professors Victor Chernozhukov and Muhamet Yildiz were reappointed.

Ivan Werning and Sergei Izmalkov will join the faculty as assistant professors as of July 1, 2002. Ivan received his PhD from University of Chicago and is a macroeconomist. Sergei received his PhD from Pennsylvania State University and is a theorist.

Assistant professor David Spector resigned his position effective June 30, 2002. He will assume a position at CEPREMAP in France.

There were twelve visiting faculty for all or part of the 2001-2002 academic year. Visiting professor Jean Tirole taught a topics course in industrial organization. Visiting professor Roger Brinner taught macroeconomics. Visiting professor Mathias Dewatripont taught microtheory. Visiting professor Kaushik Basu taught microeconomic theory and development economics. Visiting professor Linda Bui taught industrial organization. Visiting professor Mark Duggan taught public finance. Visiting professor Ephraim Kleiman taught the economics of the Middle East. Visiting professor Paul Milgrom taught microeconomic theory. Visiting professor Stephen Machin taught labor and microeconomics. Visiting professor Hans-Joachim Voth taught econometrics. Postdoctoral associate Mark Wright taught macroeconomics . Instructor Christian Hellwig taught undergraduate advanced macroeconomics.

On women and minorities in the department. The department has three women faculty members, two of whom are tenured, and no minorities. All search committees are instructed to identify outstanding women and minority candidates as part of their search process. As part of the regular recruitment process for junior faculty, the department solicited/received 153 CVs. Twenty candidates (including two women) were selected for interviews. This year however, none of the three offers went to a woman or a minority.

Honors and Awards

Professor Daron Acemoglu was the Review of Economic Studies Lecturer at The Royal Economic Society Meetings. He was gave the keynote address at the European Association of Labor Economists meeting.

Professor Joshua Angrist was the Hooker Distinguished Visiting Professor at McMaster Univeristy.

Assistant professor David Autor was a fellow at the Center for Advanced Study in the Behavioral Sciences at Stanford University.

Professor Banerjee is the co-winner of the Mahalanobis Memorial Medal for 2000 from The Indian Econometric Society, along with Alan Krueger of Princeton University.

Professor Blanchard gave the Zvi Griliches lectures in Moscow in November of 2001. He was also elected to the Econometric Society Council.

Professor Caballero received the 2002 Frisch Medal of the Econometric Society.

Professor Diamond is the president of the American Economic Association.

Professor Dornbusch was awarded the Perkins Award for Excellence in Graduate Advising.

Professor Duflo was a John M. Olin Faculty Fellow. She has been awarded an Alfred P. Sloan Foundation Fellowship for 2002-2003.

Professor Gabaix has been awarded a Russell Sage Foundation Fellowship for 2002-2003.

Professor Bengt Holmstrom was awarded the American Finance Association's Smith Breeden Distinguished Paper Prize for his article "LAPM—A Liquidity-Based Asset Pricing Model" (with Jean Tirole.) He gave the Rogers Clark Lecture at North Carolina State University, the keynote address at the Annual Meeting of the Finnish Society of Sciences and Letters, and the Karl Borch Lecture at the Norwegian School of Economics. He was also elected a fellow of the European Corporate Governance Institute.

Professor Paul Joskow is the president-elect of the International Society for New Institutional Economics. He gave the Fathauer Lecture at the University of Arizona. He also was awarded the Undergraduate Economic Association Teaching Award.

Professor Mullainathan was an Alfred P. Sloan Foundation Fellow. He has been awarded a John M. Olin Faculty Fellowship for 2002-2003.

Professor Poterba gave the Hahn Lecture to the Royal Economic Association. He was the American Council on Capital Formation Distinguished Scholar. He is a member of the executive committee of the American Economic Association. He was the recipient of the MIT Graduate Economics Association Teacher of the Year award.

Professor Nancy Rose is a member of the nominating committee of the American Economic Association.

Professor Temin is the president of the Eastern Economic Association. He was a Guggenheim Fellow.

Research Achievements

Professor Acemoglu's paper "Technical Change, Inequality and Labor Market" was in the *Journal of Economic Literature*.

Assistant professor George-Marios Angeletos's paper "Fiscal policy with Non-contingent Debt and the Optimal Maturity Structure" will be published by the *Quarterly Journal of Economics* in August of 2002.

Professor Angrist's paper "How Do Sex Ratios Affect Marriage and Labor Markets? Evidence from America's Second Generation," is forthcoming in the *Quarterly Journal of Economics*.

Professor Autor's article "Outsourcing at Will: Unjust Dismissal Doctrine and the Growth of Temporary Help Employment" is forthcoming in the *Journal of Labor Economics*.

Professor Blanchard's paper "The Dynamic Effects of Changes in Government Spending and Taxes on Activity" written with Roberto Perotti is forthcoming in the *Quarterly Journal of Economics*.

Professor Caballero's paper "International and Domestic Collateral Constraints in a Model of Emerging Market Crises," written with Arvind Krishnamurthy, was published in the *Journal of Monetary Economics*.

Professor Chernozhukov's paper "3-step Censored Quantile Regression and Extramarital Affairs," written jointly with H. Hong, was published in the *Journal of the American Statistical Association*.

Professor Costa's paper "Estimating Real Income in the U.S. from 1888 to 1994: Correcting CPI Bias Using Engel Curves" was published in the *Journal of Political Economy*.

Professor Duflo's paper "Participation and Investment Decisions in a Retirement Plan: The Influence of Colleagues' Choices," written with Emmanuel Saez, is forthcoming in the *Journal of Public Economics*.

Professor Glenn Ellison's paper "Geographic Concentration as a Dynamic Process" was published in the *Review of Economics and Statistics*.

Professor Frank Fisher wrote "U.S. v. Microsoft – An Economics Analysis" with D. L. Rubinfeld, which appeared in *The Antitrust Bulletin*.

Professor Gabaix's paper "Similarities and Differences between Physics and Economics," written with L.A. N. Amaral, P. Gopikrishnan, H. Eugene Stanley, and V. Plerou, appeared in *Physica A*.

Professor Jonathan Gruber's "The Elasticity of Taxable Income: Evidence and Implications" was published in the *Journal of Public Economics*.

Professor Jeffrey Harris' paper "Smoke Yields of Tobacco-Specifics Nitrosamines in Relation to FTC Tar Level and Cigarette Manufacturer: Analysis of the Massachusetts Benchmark Study" was published in the *Journal of the National Cancer Institute*.

Professor Jerry Hausman published his paper "Mismeasured Variables in Econometric Analysis: Problems from the Right and Problems from the Left" in the *Journal of Economic Perspectives*.

Professor Holmstrom's paper "LAPM – A Liquidity –Based Asset Pricing Model," written with Jean Tirole, was published in the *Journal of Finance*.

Professor Joskow's paper "Transaction Cost Economics, Antitrust Rules and Remedies" was published in the *Journal of Law, Economics and Organization*.

Assistant professor Guido Kuersteiner's work "Asymptotically unbiased Inference for a Dynamic Panel Model with Fixed Effects," written with Jinyong Hahn, is forthcoming in *Econometrica*.

Professor Whitney Newey's paper "Choosing the Number of Instruments" was published in *Econometrica*.

Professor Michael Piore's paper "Economics and Sociology" was published in *Revue Économique*.

Professor Poterba's paper "Demographic Structure and Asset Returns" was in the *Review of Economics and Statistics*.

Professor Rose's article "Regulating Executive Pay: Using the Tax Code to Influence Executive Compensation" is forthcoming in the *Journal of Labor Economics*.

Professor Spector's paper "Failure of communication despite close preferences" was published in *Economic Letters*.

Professor Temin's "A Market Economy in the Early Roman Empire," was published in the *Journal of Roman Studies*.

Professor Ventura's article "Product Prices and the OECD Cycle," written with Aart Kraay, was published in *Advances in Macroeconomics*.

Professor William C. Wheaton published his article "Intra-Urban Wages Variation, Employment Location and Commuting Time," written with Darren Timothy, in the *Journal of Urban Economics*.

Professor Yildiz's "Bargaining over risky assets" was published in *Game Theory in the Tradition of Bob Wilson*, edited by B. Holmstrom, B.P. Milgrom, and A. Roth.

Olivier Blanchard
Department Head
Class of 1941 Professor of Economics

More information about the Economics Department can be found on the web at http://econ-www.mit.edu/.

Foreign Languages and Literatures

Foreign Languages and Literatures (FL&L) is dedicated to providing MIT students with the tools for a sensitive and successful involvement in the global community, and to contributing to the internationalization of their MIT education. During the academic year 2001-2002, FL&L faculty continued to provide national and international leadership in the fields of foreign language pedagogy, technology in the humanities, and literary and cultural studies, while demonstrating their commitment to educational excellence within the Institute.

Highlights of the Year

Professor of Spanish and Latin American Studies Elizabeth Garrels will serve as section head starting July 2002, succeeding professor of French Studies Isabelle de Courtivron. Also in July 2002, assistant professor of Chinese Emma Teng will be promoted to associate professor of Chinese, and will hold the Class of 1956 Career Development Professorship; lecturer in Spanish Margarita Ribas-Groeger will become director of Spanish language studies; and lecturer in Japanese Yoshimi Nagaya will be appointed director of Japanese language studies.

FL&L will also welcome two new members to the section: Ian Condry will be appointed assistant professor of Japanese cultural studies, and Charity Scribner will be appointed assistant professor of European cultural studies, both starting in July 2002. Lecturer in German and MIT-Germany program director Bernd Widdig was named associate director of the MIT International Science and Technology Initiative (MISTI) in November 2001. Two faculty members, Professors Garrels and associate professor of Hispanic Studies Margery Resnick, were on leave during AY2002, and research associate Fendt spent two months as a visiting scientist at the German National Research Center for Information Technology at the Fraunhofer Institute in St. Augustin, Germany.

In June, Professor Resnick was elected an honorary member of the Association of Alumni and Alumnae of MIT. She was cited at length for her wonderful women's oral history project, and also for the numerous other contributions she has made to the education of MIT students over the years. Director of English language studies (ELS) Jane Dunphy and lecturers Ribas-Groeger and Nagaya were recognized for their outstanding contributions to teaching and service to the School of Humanities, Arts, and Social Sciences with 2002 SHASS Infinite Mile Awards. In addition, FL&L received a generous gift of $725,000 for the French language curriculum from an alumnus in April. The funds will be used to increase the presence, visibility, and importance of French language, culture, and society on the MIT campus. Plans for a two-week immersion of cultural life in Paris during MIT's Independent Activities Period (IAP), and for transferring to CD-ROM the language-learning application A la Rencontre de Philippe, by senior lecturer in French Gilberte Furstenberg, have already begun.

During AY2002, FL&L brought to MIT acclaimed author Eva Hoffman as a visiting professor, José F. A. Oliver as a Max Kade Distinguished Writer-in-Residence, and Arundhati Tuli Banerjee as a Center for Bilingual/Bicultural Studies (CBBS) Fellow and FL&L lecturer. Visiting professor Hoffman, author of Lost in Translation and Shtetl, taught "Where East Meets West: Contemporary Literatures of Exile" and presented her work in a talk entitled "Memory and History," co-sponsored with the Writing Program. Writer-in-residence Oliver taught "The New Spain: 1977–Present" and "Twentieth Century German Literature," and performed "Concert of Poetry in Spanish, German and English" with poet, singer, and guitarist Niño de Pantaleon. Lecturer Banerjee served as coordinator of Studies in International Literatures and Cultures (SILC) and organized both a lecture by well-known author Amitav Ghosh and an Indian Film Series.

Special events for the year included talks by noted authors Claude Hagège, Richard Rodriguez, and Ilan Stavans, all hosted by FL&L; as well as other talks by José Carvajal, Ambroise Kom, Leïla Sebbar, Genevieve Sellier, Ahdaf Soueif, and Ibrahim Ward, co-sponsored by FL&L.

Outside MIT, members of FL&L served in various leadership capacities involving the study of foreign languages and literatures. Professor de Courtivron was a member of the Jury du Prix Yourcenar, Boston. Professor of Chinese cultural studies Jing Wang was a proposal reader for the National Humanities Center, as well as an external examiner for the Department of Comparative Literature at the University of Hong Kong and the Department of Cultural Studies at Lingnan University, Hong Kong. Associate director and professor of comparative media studies William Uricchio was an organizer of the Media and European Identity conference in Brussels. Senior lecturer in Spanish Douglas Morgenstern served as MIT's representative on the governing board of the Consortium for Language Teaching and Learning. Professor Resnick continued as president of the International Institute in Spain. Lecturer Widdig was co-chair of the German Study Group at the Center for European Studies at Harvard University. Senior lecturer in German Ellen Crocker served on the executive board of the American Association of Teachers of German. Lecturer Nagaya was on the advisory board of the New England Association of Teachers of Japanese.

Finally, beginning in the fall semester, 2002, FL&L will offer students the opportunity to minor in Chinese language studies. The HASS Chinese Language Minor is designed for students who have completed an initial year of Chinese language study and would like to pursue advanced work in Chinese literature, history, and culture.

Awards and Grants

Outside MIT

Professor Wang is the principal investigator (with A. Saich at Harvard's Kennedy School of Government) of a three-year grant from Harvard University's Asia Center for an inter-university research program entitled "Policy Culture in Contemporary China."

Professor Uricchio is the director of "Changing Media, Changing Europe," a Media and Cultural Identity Project funded by the European Science Foundation.

Professor of Japanese and linguistics Shigeru Miyagawa continued his work on the course "Media, Education, and the Market Place" with funds awarded by Fuji Xerox.

The Consortium for Language Teaching and Learning remains a strong supporter of FL&L multimedia projects. Consortium support was given for lecturer in Chinese Tong Chen's web-based project "Life and History in a Tianjin Restaurant." Senior lecturer Crocker and research associate Kurt Fendt advanced their work on "Berliner Sehen" and "Berliner Sehen Exchange," two web-based teaching projects funded by the consortium. Progress was also made this year on several other consortium-funded projects: lecturer Ribas-Groeger and lecturer in Spanish Adrianna Gutiérrez-Gonzalez's "Immigrant Voices: Stories from Hispanic Communities in Boston," a collection of video interviews with Hispanic immigrants in the Boston area; senior lecturer in Chinese Julian Wheatley's book "Learning Chinese: A Beginning Course in Chinese"; Lecturer Nagaya's book "Kawariyuku Nihon no Syakai: Advanced Japanese Textbook"; and Lecturer in French Johann Sadock's web project "Au-dela regard: rencontres multiethniques."

Within MIT

A number of projects by FL&L members have received support from MIT. Professor Miyagawa received funds, in collaboration with Comparative Media Studies (CMS), from the Campus Committee on Race Relations for research on the Young Historian Project. Professor Wang's research has led to the establishment of an international committee on critical policy studies of China at the Center for International Studies. Committee participants include the University of Technology and Science in Sydney, Australia; the Chinese Academy of Social Sciences, the Center for Oral History at Tsinghua University; the Center for Cultural Studies at Shanghai University; the Center for Popular Culture Studies at Peking University; the Transcultural China Project at Rice University; and the Hong Kong University of Science and Technology.

Professor Uricchio is head of Global Media and Cultures, an MIT-CMS research consortium project. Lecturers Ribas-Groeger and Gutiérrez-Gonzalez received funding from MIT's dean of undergraduate studies, dean of humanities, CBBS, and FL&L for the "Latina Interview Project," a collection of MIT graduate and undergraduate video interviews documenting the history and experience of Latina women at the Institute. Lecturer in German Dagmar Jaeger received a travel grant from the Marion and Jasper Whiting Foundation for a multimedia project examining how physical and fictional sites come to embody the reconstruction of past events and experiences in contemporary German culture.

Visiting associate professor Odile Cazenave received a dean's award for the translation of her forthcoming book Nouvelle Afrique sur Seine. Research associate Fendt and senior lecturer Morgenstern continued work on the MITUPV Exhange, a web project with the Universidad Politécnica de Valencia, Spain, supported by the MIT Alumni Fund and the consortium. Lecturer Ribas-Groeger continued work on "Módulos culturales: España de cerca," a multimedia web-based study unit on life and culture in contemporary Spain as part of the MetaMedia project directed by research associate Fendt and funded by the MIT D'Arbeloff Fund.

Research and Publications

Professor of French Studies and film Edward Baron Turk's book *Marcel Carné et l'âge d'or du cinéma français* was published in Paris by L'Harmattan in May 2002.

Professor Miyagawa's chapter "The EPP, Scrambling, and Wh-in-siu" appeared in M. Kenstowitcz's book *Ken Hale: A Life in Language*.

Professor Teng's chapter entitled "A Brief Record of the Eastern Ocean by Ding Saoyi" was published in Susan Mann's book *Under Confucian Eyes: Texts on Gender in Chinese History*.

Professor Uricchio published a number of papers: "Cultural Studies: una visione d'insieme," in *Storia del cinema mondiale: Theorie, strumenti, memorie*; "Medien des übergangs und ihre Historisierung," in *Archiv für Mediageschichte--Mediale Historiographien*; "TeleVisionen. Historiografien des Fernsehens," in *Oesterreichische Zeitschrift für Geschichtswissenschaften*; "Celluloid Shakespeare and the Complexities of Cultural Meaning," (with Pearson) in *Kulturstudier nr. 19: The Aesthetics of Popular Art*; and he wrote *Cultuurveranderingen in een digitaliserend tijdperk; een geesteswetenschappelijk perspectief*, a commission final report to the Dutch Minister of Higher Education and the Royal Dutch Academy of Science.

Professor Resnick's paper "Gender Differences in Career Progress and Satisfaction in an Academic Medical Center" appeared in the *Journal of the American Medical Women's Association*.

Lecturer Widdig's paper "Dr, Mabuse, der Spieler und die deutsche Inflation" was published in *Der Deutschunterricht*.

Research associate Fendt's paper "Leser auf Abwegen–Hypertext und seine literarischen Vorbilder" was published in "Text & Kritik," a special issue of *Digitale Literatur*.

Visiting professor Cazenave had the following articles published: "Leaving the Islands: New Routes, New Destinations in Recent French Caribbean Literature by Women," in the *Wellesley Colloquium on Caribbean Studies* and "Francophone Women Writers in France in the Nineties," in *Women in France*.

Lecturer in Spanish José Ramos's paper "Naturalismo modernista y romántico en los cuentos de Baldomero Lillo, Javier de Viàna y August d'Halmar" was published in *Excavatio*.

Besides publishing their own research, FL&L faculty members continue to serve in key editorial positions on a number of publications.

Professor Wang edited "Chinese Popular Culture and the State," a special issue of *Positions: east asia cultures critique*. She is also on the advisory board for the journal *Inter-Asia Cultural Studies*, a consulting editor for the *Encyclopedia of Contemporary Chinese Culture* (Routledge), and a member of the editorial board for the book series *Critiques/Culture Studies* (Ju-Liu Publishing Co.) and the *Cultural Studies Book Series* (Hong Kong University Press).

Professor Miyagawa served as associate editor of *Language*, a journal of the Linguistic Society of America, as well as of the *Journal of East Asian Linguistics*, *Journal of Japanese Linguistics*, and *Linguistic Inquiry*, published by MIT Press.

Professor Turk continued his work as assistant film editor for *The French Review*, a journal of the American Association of Teachers of French.

Professor Uricchio served as an editor of TIC: Trends in Communication and "Early and Silent Film," in the *Annotated Bibliography for English Studies* (CD-ROM); a contributing editor for *The International Journal of Cultural Studies*, *Routledge Encyclopedia of Early Cinema*, *British Film Institute New Media Series*, and *CineGraph Dokumenta*; a member of the editorial board for *E-View: een elekrtronisch magazine* over theater, film televisie and digitale media, *Intensities: The Journal of Cult Media*, *Tijdschrift voor Mediageschiedenis*, and *Mediawissenschaft: Rezensionen*; and on the advisory board for the *Routledge Dictionary of Cultural Studies*.

Visiting professor Cazenave was the guest editor of *Présence Francophone 58*, *Ecritures Francophones et Immigration* and wrote its introduction.

Conferences and Presentations

Professor de Courtivron presented "Plus ça change: de l'écriture féminine à la parité" at the 20th Century French Studies colloquium at the University of Connecticut.

Professor Resnick was the chair of the international colloquium on "Women and the Future of Religion" at the International Institute in Spain, presented "Fantasy and the Corporation" at a Harvard University colloquium, and was part of a forum on "Women Writers in Spain" at the Universidad de Complutense, Madrid.

Professor Miyagawa presented talks on "Learning on the Internet: MIT's OpenCourseWare" and "Media, Education, and the Marketplace" at the International Conference on E-learning, and "Some Consequences of the EPP Approach to Scrambling" and "Uses of the Internet for Teaching Japanese" at Georgetown University.

Professor Wang was invited to Harvard University's Fairbanks Center to give the talk "Advertising in Contemporary China: A Cultural Industry in Transition."

Professor Uricchio was the keynote speaker at Input 2002, a meeting of the International Association of Television Producers, where he presented "Digital Frontiers;" at the European Science Foundation in Copenhagen, where he presented "Cyber-citizenship: Political Identity, On-Line Games and Virtual Worlds"; and at the Media and European Identity conference in Brussels, where he presented "Conceptualising Identity: Strategies for a Global Era." He also presented "Television's Provocation to Media History" at Universitaet Paderborn and "Re-defining Television Studies" at Ruhr-Universitaet Bochum.

Professor Teng served as chair and discussant for the "Chinatown Conference" at the Asian Cultural Studies Humanities Center, Harvard University.

Associate professor of Hispanic Studies Nicolas Wey-Gomez presented "The Natural Magic of Prayer in Alvar Nunez Cabeza de Vaca's Naufragios" at a Modern Language Association conference.

Director Dunphy presented "Teaching the Impromptu" at the ABC West Conference in Seattle, and was invited to speak at the Woods Hole Oceanographic Institution on "Keys to Effective Professional Presentations."

Research associate Fendt gave talks on "Forget the Technology!— Considerations for Developing Interactive Media Applications for Foreign Languages" at Brown University, "Komplexe Inhalte, Hypertext und Metadaten–Exploratives Lernen mit hypermedialen Medien" at the RWTH Aachen (Technical University), Germany, and "Berliner sehen–eine hypermediale Lernumgebung für Deutsch als Fremdsprache" at the University of Potsdam, Germany. He was also invited to give a workshop on "Visible Knowledge" at Georgetown University.

Senior lecturer Furstenberg was invited to be the keynote speaker at both the Computer Assisted Language Instruction Consortium (CALICO) 2002 Conference at the University of California, Davis, where she presented "Creating Virtual (and Real) Communities: Some

Reflections," and at the Michigan Foreign Language Association, where she presented "Technology: How Does It Change our Teaching? Some Lessons Learned." She also gave talks on the Cultura Project, a web-based approach for constructing in-depth understanding of a foreign culture, at the University of New Hampshire, Middlebury College, Southern Conference on Language Teaching, and National Endowment for the Humanities. In addition, she led workshops on "Developing Cross-cultural Understanding in the Foreign Language Class" at the Premier Forum Annuel sur L'enseignement et L'apprentissage in Ottawa, Canada, and "Technology and Culture: New Connections, Insights and Approaches" at the Michigan Foreign Language Association.

Lecturers in ELS Patricia Brennecke and Mary Christie attended the Second Annual Linguistics Colloquium at the University of Havana and presented "Avoiding Plagiarism: Teaching Summary and Paraphrase" and "The Art of Clarifying," respectively.

Lecturer Chen was the roundtable chair of "Issues in the Use of Multimedia in Chinese Language Teaching" at the NEAAS at Williams College.

Visiting professor Cazenave was the moderator of roundtable discussions on "Écrire depuis l'Afrique" at the Fest'Africa festival of African literature in Lille, France, and "Caribbean Women Artists: Expressing/Resisting Globalization," held at MIT. She also presented "Boubacar Boris Diop's Murambi, le Livre des Ossements and Ken Bugul's La Folie et La Mort: Rethinking Memory and Engagement" at the annual conference of the African Studies Association; organized "Youth and the City, A Conversation with Writers and Filmmakers from Africa and the Caribbean," a film projection and discussion of Jean Marie Teno's work; presented "De La Grande Dévoreause d'Isabelle Boni-Claverie a La Folie et La Mort de Ken Bugul: Nouveaux Regards sur La Jeunesse et La Ville" at the Conseil International d'Études Francophones; and presented "La jeunesse et La Ville dans Le Cinéma African" at the African Literature Association convention.

Senior lecturer Morgenstern presided over a session on "Teaching Language and Literature Online" at the Annual MLA Convention.

Senior lecturer Wheatley presented "Language Teaching and Area Studies" at the Association of Asian Studies annual meeting.

Lecturer Widdig gave talks on "Building an Internship Program" at the International Engineering Education Conference, University of Rhode Island; "Globalization and the Study of German" at the University of York, Ontario; and "Inflation and Intellectuals in Weimar Germany" at the international conference on "Rethinking Weimar" at the University of Michigan.He also gave a workshop on "Collaborations in the Field of Foreign Languages and Literatures" at Cambridge University.

Lecturer Sadock presented the paper "Anti-Arab Anti-French Tendencies in Post-1948 Oriental Jewish Literature Written in French" at the 35th Annual Texas Tech University Comparative Literature Symposium on Transnational Cultures, Diasporas, and Immigrant Identities in France and the Francophone World.

Lecturer Ramos presented several papers during the year: "Visiones paralelas de Nueva York: José Martí y Frederico García Lorcas" at the Quest for Meaning Through the Coexistence of Ideologies International Graduate Conference at Boston College; "Surrealist and Naturalist Schizophrenia: Federico García Lorca's Poet in New York" and "Revenge of the Vampire: The Mad Scientist's Creation of the Femme Fatale in a Short Story by Horacio Auiroga" at the Emile Zola and Naturalism international conference at the University of Jaén; and "Morel's Invention and the 13th Floor: Existence through Technology" at the 26th Annual Colloquium on Literature and Film at West Virginia University.

Outreach Programs

FL&L faculty and lecturers participated in two programs that reached out to the extensive educational and foreign language community outside MIT. In January, Professor de Courtivron, Senior lecturers Furstenberg, Morgenstern and Wheatley, lecturer Widdig, and research associate Fendt participated in a workshop entitled "Language and Culture: Teaching with Technology" at Selwyn College in Cambridge, England, as part of the Cambridge-MIT Institute (CMI). The workshop explored possibilities for collaboration while investigating relevant curriculum development for MIT students wishing to study languages at Cambridge, and to transfer credits to MIT. In the spring, FL&L hosted teachers from the Phillips Exeter Academy for a one-day visit. Teachers attended classes and conversed with faculty to discuss their foreign language curriculum.

Programs at MIT

Faculty and lecturers also participated in several programs organized at MIT. Many in the section participated in the Media in Transition 2: Globalization and Convergence conference sponsored by CMS. Lecturer Banerjee gave one of the keynote speeches and presented her paper "The Goddess and the Demon: Contested Territories in Durga Puja." Professors Miyagawa, Turk, Wang, Uricchio, visiting associate professor Cazaneve, and research associate Fendt were moderators. Professors de Courtivron and Resnick participated in the Teachers as Scholars Program funded by the Mellon Foundation. Professor Resnick continued to serve on the Faculty Committee on the Library System, which formulates policy for the administration of the libraries, and was director of the MacVicar/Oral Histories of MIT Women Graduates. Professor Wang was co-director of the research lab "Global Media Culture" for CMS. Professor de Courtivron and visiting professor Hoffman participated in the Women's League panel

"Women and Writing." Senior lecturer Furstenberg, lecturer Banerjee, and visiting scholar Chiu-Mi Lai also participated on a panel hosted by the Women's League, "Four Generations of Women." Lecturer Widdig gave the presentation "Higher Education in the US: A Model for the German University Reform?" to a delegation from the State of Hesse, Germany, sponsored by the Industrial Liaison Program. Lecturer Ribas-Groeger was an advisor with Lynn Roberson from Counseling and Support Services for "Mujeres Latinas," and part of the MIT-Mexico organizing committee. Senior lecturer Wheatley was housemaster of the East Campus residence and director of the China/Singapore Programs, MISTI.

MIT Service and Enrollments

FL&L faculty members further contribute to MIT through their service on a number of Institute-wide committees, including the Academic Computing Strategic Planning Committee, the Committee for Undergraduate Policy, the Burchard Scholars, the Women's Studies Steering Committee, Women's Studies Programming Committee, CMS Steering Committee, CMS Graduate Admissions Committee, the Life-Long Learning Committee, the Subcommittee on the Undergraduate Communication Requirement, the IS Server Discovery Project, the Transforming Humanities Education Research Group in CMS, the Pedagogy and Interactive Technology Forum, the Crosstalk Forum, Media in Transition Conference Committee, the Edgerton Prize Committee, the Institute Nomination Committee, International Film Club, and the CMS Graduate Student Orientation Committee.

To achieve diversity, FL&L has maintained its commitment to making full-time appointments and attracting qualified candidates from minority groups. To achieve these goals, FL&L has targeted historically black colleges and universities and has advertised in journals and association web sites reflecting minority community interests. We currently have several members of minority communities and women serving on our full-time faculty and full-time and part-time teaching staff.

There is one student majoring in FL&L. The number of minors is 21, and the number of concentrators is 418. Spanish continues to have the largest enrollments at 528, followed by English, 294; French, 271; Chinese, 240; Japanese, 237; German, 173; and Italian, 23 (only offered during IAP). Enrollments in Studies in International Literatures and Cultures (cross-cultural language and culture subjects taught in English) were 330.

Isabelle de Courtivron
Section Head
Professor of French Studies

More information about the Foreign Languages and Literatures Section can be found on the web at http://web.mit.edu/fll/www/.

History

The mission of the History Faculty is to promote advanced research and undergraduate teaching in a broad range of fields, including American, Ancient, East Asian, European, Latin American, Middle Eastern, and Russian history. The faculty includes joint appointments in Urban Studies, in Writing, and in Science, Technology, and Society, and it participates in the joint PhD program in the History and Social Study of Science and Technology.

Professor John Dower's Embracing Defeat: Japan in the Wake of World War II (W.W. Norton) won the Osaragi Jiro Rondan Special Prize for the Japanese translation version, awarded by the Asahi newspaper, and the Yamagata Banto prize for promoting Japanese culture abroad, awarded by the Osaka prefectural government in Western Japan.

Professors Pauline Maier and Merritt Roe Smith published *Inventing America: A History of the United States* (W.W. Norton), a textbook that reconfigures American history by integrating technology and science into the usual discussions of politics and society. The other authors are Alex Keyssar of Duke University and Daniel Kevles of Yale.

Professor Robert Fogelson's *Downtown: Its Rise and Fall, 1880-1950* (Yale University Press) won the Lewis Mumford Prize for the best book on American city and regional planning history, awarded by the Society for American City and Regional Planning History.

Associate professor Heather Cox Richardson published *The Death of Reconstruction: Race, Labor, and Politics in the Post-Civil War North, 1865-1901* (Harvard University Press), which demonstrates the importance of class in the post–Civil War struggle to integrate African-Americans into a progressive and prospering nation.

Professor Harriet Ritvo published "Destroyers and Preservers: Big Game in the Victorian Empire" in *History Today*. Professor Peter Perdue published "Empire and Nation in Comparative Perspective: Frontier Administration in Eighteenth-Century China" in the *Journal of Early Modern History*. Professor Bruce Mazlish published "Evolving Toward History" in *Evolution and History*. Associate professor Anne McCants published "Petty Debts and Family Networks" in *Women and Credit* (edited by Beverly Lemire). Associate professor Elizabeth Wood published "The Trial of the New Woman: Citizens-in-Training in the New Soviet Republic" in *Gender and History*. Associate professor Jeffrey Ravel published "Gender, Enlightenment, and Revolution in Two Eighteenth-Century Biographies" in *French Historical Studies*. Assistant professor Joshua Sosin published "Boeotian Silver, Theban Agio and Bronze Drachams" in the *Numismatic Chronicle* and "A Missing Woman: Hellenistic Leases from Thespiae Revisited" in *Greek, Roman, and Byzantine Studies*. Lecturer Mona Russell published "Competing, Overlapping, and Contradictory Agendas: Egyptian Education under British Occupation, 1882-1922" in *Comparative Studies of South Asia, Africa, and Middle East*.

Professor Dower analyzed Japanese and American images of the enemy in World War Two at the Pearl Harbor 60th Anniversary Conference sponsored by the USS Arizona Memorial. Professor Ritvo spoke on "Varieties of Taxonomic Experience" at Cambridge University, England. Professor Wood presented a paper on "Shaming Boys Who Smoke Cigarettes: Agitation Trials in the Late 1920s" at the American Association for the Advancement of Slavic Studies. Professor Perdue spoke on "From Turfan to Taiwan: Trade and War on Two Chinese Frontiers" at the International Conference of Asian Studies in Berlin. Assistant professor Meg Jacobs presented a paper on "Pocketbook Politics: Democracy and the Market in Twentieth-Century America" at the Policy History Conference. Professor Mazlish presented a paper on "What Is New about Globalization? An Historian's Perspective" at the Yale Center for the Study of Globalization. Assistant professor Jonathan Zatlin spoke on "Selling Socialism: Advertising in East Germany, 1971-1989" at the German Studies Association Conference.

Associate professor Ravel will be promoted to associate professor with tenure, effective July 1, 2002, on the basis of his research in the cultural history of 17th and 18th-century France, and his contributions to the European history curriculum. After a national search, the History Faculty appointed Christopher Capozzola as assistant professor in the field of 19th and early 20th-century American history. He received his doctorate from Columbia University for a dissertation entitled "Uncle Sam Wants You: Political Obligations in World War I America."

Professors Maier, Mazlish, Perdue, Ritvo, Richardson, Wood, and Jacobs participated in the joint PhD program in the History and Social Study of Science and Technology by teaching graduate seminars, setting general examinations, and supervising dissertations. Professors Dower and Ritvo and Professor Philip S. Khoury advised Harvard graduate students in Japanese, British, and Middle Eastern history, respectively. Professors Wood and McCants participated in the inter-university graduate Consortium in Women's Studies.

Professor Dower received an honorary Doctor of Humane Letters degree from Amherst College. Professor Khoury was elected a fellow of the American Academy of Arts and Sciences and was appointed the first Kenan Sahin dean of the School of Humanities, Arts, and Social Sciences. Professor Sosin was awarded a fellowship in ancient Greek studies at the Center for Hellenic Studies. Professor

Ritvo was awarded a senior fellowship at the National Humanities Center. Professor Zatlin received the Fritz Stern Dissertation Prize for his dissertation "The Currency of Socialism: Money in the GDR and German Unification, 1971-1990."

History enrollments totaled 273 in the fall semester and 368 in the spring. Three history majors successfully completed their senior thesis projects: Edward Cotler's "Propaganda on the Home Front: Nazi Germany and Soviet Russia in World War II," supervised by Professor Zatlin; Kristopher M. Schnee's "America's Crusade: War with the Barbary Pirates, 1789-1805," supervised by Professor Richardson; and Michael C. Won's "Social

Darwinism and Educational Reform in Nineteenth-Century Britain," supervised by Professor Ritvo. Nine seniors graduated with minors in history. Two new subjects were offered: 21H.437 European Socialism, 1796-1989 (Zatlin); and 21H.441 Revolutionary Europe (Zatlin).

Two faculty members led freshman advisor seminars: Dean Khoury, "Conflict and Peace in the Contemporary Middle East," and Professor McCants, "You Have to Eat." Professors Jacobs, McCants, Ravel, and Sosin supervised UROP projects.

Professor Perdue served as head of the HASS Overview Committee. Professor Ritvo served on the HSSST Graduate Program Steering Committee. Professor Wood served as chair of the Women's Studies Program Committee. Professor Jacobs directed the Truman Scholarship Committee and served as chair of the newly established History Prize Committee. Professor McCants served as president of MIT's Phi Beta Kappa chapter. Two historians were housemasters: Professor McCants of Green Hall, and associate professor William Watson of Baker House.

The Sahin Lecture Series for 2001-2002 included the following presentations: William Cronon on "The Portage: A Place in Time (Reading from a Work in Progress)," and Herbert Bix on "Expedient Nationalism and Structural Reform: What Path is Koizumi Forging?" Professor Mazlish, again, jointly organized the monthly meetings of the History and Literature Workshop, and Dean Khoury directed the Bustani Middle East Seminar.

Harriet Ritvo
Section Head
Arthur J. Conner Professor of History

More information about the History Faculty can be found on the web at http://web.mit.edu/history/www/.

Department of Linguistics and Philosophy

The Department of Linguistics and Philosophy divides into two sections consisting of 26 faculty members (four of them jointly appointed), 67 graduate students, two dozen or so visiting scientists and scholars, an administrative officer, a student administrator, network administrator, lab manager, and five support staff members. Each section operates independently; yet between them there is a significant overlap of intellectual interests in education and research, spanning the faculty, graduate students, and visitors.

In the most recent (1995) National Research Council rating of graduate programs in the United States, Linguistics and Philosophy were ranked first and tenth, respectively, on faculty quality and second and seventh, respectively, on program effectiveness.

Research

Linguistics

The linguists continue to pursue an account of natural language in terms of principles of computation and representation. The Minimalist Program for Linguistic Theory, Optimality Theory, and the Theory of Distributed Morphology offer somewhat different yet sometimes complementary suggestions for the course that the pursuit might follow. These ideas continue to be explored, developed, and challenged by MIT graduate students, faculty, and visitors in research on syntax, semantics, morphology, phonology, and on the interfaces between these modules of the grammar of natural language.

Neurolinguistic research continues with the move of the KIT/MIT MEG Lab to Building 24. The MEG Lab hosts interdisciplinary research by scientists across MIT and the greater Boston scientific community. The department has also continued to provide support for experimental research in language acquisition, acoustic phonetics, and sentence processing.

Fieldwork on less-studied and endangered languages has become an increasingly important research emphasis for students and visitors. The department is exploring ways to further fund this research in the future.

Philosophy

Research in philosophy is not so neatly programmatic as it is in linguistics; thus it is best simply to list the wide range of topics pursued in current research in philosophy at MIT, including but not exhausted by the following: theories of consciousness and the mind-body problem; causation and laws of nature; analysis of fundamental metaphysical concepts: substance, attribute, essence, set, identity, and the like; problems at the intersection of ethics and historical sociology; foundational questions of quantum physics; the nature and confirmation of scientific theories; applied aesthetics; the foundations of "possible worlds" semantics for modal and conditional logics; the ontology of events; the identity across time of people and other physical objects; the principles of rationality governing ethical reasoning; and the role of evaluative thoughts in practical reasoning.

Publications

As in the past, the faculty on both sides of the department participated in a large number of colloquia and acted as keynote speakers at conferences and workshops in various parts of the United States and the world. In addition a number of our faculty served as editors and/or members of editorial boards for numerous journals both in the United States and abroad. They also published a large number of journal articles, book chapters, and reviews.

Books published in 2001-2002 include Institute Professor Noam Chomsky's *9-11* (Seven Stories Press, 2001) and *Understanding Power* (New Press, 2002), and Professor Irving Singer's *Exploration in Love and Sex* (Rowman & Littlefield Publishers, 2001).

Honors and Awards

Professor Chomsky received the Rabindranath Tagore Award, Asiatic Society, Calcutta, 2001. Professor Judith Thomson was elected to a three-year term as chair of the American Philosophical Association National Board of Officers. The American Philosophical Association's board invited Professor Thomson to give the Carus Lectures 2003. Professor Joshua Cohen was elected a fellow of the American Academy of Arts and Sciences and Romanell-Phi Beta Kappa Professor of Philosophy, 2002-2003. Professor Singer was a fellow of the European Humanities Research Centre at Oxford University England in 2001-2002. Associate professor Michel DeGraff was awarded a research fellowship from the National Endowment for the Humanities.

Leaves of Absence

Associate professor Kai von Fintel and Professor Robert Stalnaker were on sabbatical leaves for the spring semester. Associate professor Sally Haslanger was on a leave without pay for the spring semester. In addition, associate professor DeGraff and associate professor Cheryl Zoll were on Junior Faculty Research Leaves in the fall and leaves without pay for the spring semester.

Personnel

Professor Chomsky retired from the Linguistics Section as of January 15, 2002. Alex Byrne was promoted to associate professor with tenure. Michael Glanzberg was promoted to associate professor without tenure.

We have hired Donca Steriade as a professor of linguistics. She will begin her tenure with us on July 1, 2002, bringing to seven the total number of women faculty members. We will continue our efforts to recruit qualified women and minority candidates to the faculty.

Alec Marantz
Department Head
Professor of Linguistics

More information about the Department of Linguistics and Philosophy can be found on the web at http://web.mit.edu/philos/www/ or http://web.mit.edu/linguistics/www/.

Literature

The highlights of 2001-2002 included the appointment of a new member of the faculty, assistant professor Noel Jackson, a specialist on romantic literature whose PhD was awarded by the University of Chicago, and the promotion of Christina Klein to associate professor without tenure (both appointments took effect on July 1, 2001).

Associate professor Shankar Raman's book *Framing India: The Colonial Imaginary in Early Modern Culture* was published by Stanford University Press, and he was promoted to tenure beginning July 1, 2002.

Lecturer Wyn Kelley was appointed senior lecturer, also to begin July 1, 2002.

Associate professor Diana Henderson was awarded the Levitan Prize, and the administrative, development and support staff team for Comparative Media Studies (Janice Ellertsen, Literature administrative officer; Chris Pomiecko, CMS program administrator; Alex Chisholm, director of communications; and R.J. Bain, Douglas Purdy, Brad Seawell, support staff) was awarded the MIT Excellence Award for Building Bridges.

Professor David Thorburn was appointed MacVicar Teaching Fellow.

Academic Program and Student Enrollment

During the past year, 1,038 undergraduates enrolled in literature subjects, 13 were registered as literature majors, 25 as minors, and 108 as concentrators in literature. A number of literature subjects and seminars were revised and new topics offered this year, including American Authors: The American Poetic Tradition (21L.512), taught by Professor John Hildebidle; and Popular Narrative (21L.430), which offered two new topics, Popular Culture in an Age of Media Convergence (Professor Henry Jenkins) and Masterminds (Professor Hildebidle).

Professor Klein offered a revised version of 21L.707 U.S. and Asian Transnational Cultures, which included distance collaboration with the National University of Singapore and the graduate Centre for Historical and Cultural Studies, Bangalore, India.

Lecturer Kelley, in conjunction with the MetaMedia Project supported by the D'Arbeloff Fund, created Midnight, Forecastle, an innovative collection of image, text and film materials for use in teaching multicultural aspects of Moby-Dick, which she used for the first time in The American Novel (21L.504).

Professor Henderson offered Literary Studies: The Legacy of England (21L.420) for the first time. This subject introduces students to literary interpretive and scholarly methodologies through the study of major works of English literature, and is intended to anchor our development of the major program in literature.

Undergraduates Joyce Lee and Lianne Habinek were jointly awarded the Eloranta Fellowship this year and will pursue doctoral study in literature at UCLA and Cambridge University, respectively.

Research and Publication

Current research by MIT Literature Faculty includes research on the novel, drama, poetry, film, television and new media, with special strength in the literature of travel and exploration, gender studies, and cross-media studies.

Professor Peter Donaldson published an article on Baz Luhrmann's Romeo+Juliet in *Shakespeare after Mass Media*, ed. Richard Burt, and created two new multimedia essays, "Game Space/Tragic Space: Julie Taymor's Titus" and "British Shakespeare in the Digital Age," as part of an ongoing project on Shakespeare film in the context of media history.

Professor Alvin Kibel's current research is in literature and ethical theory and literature and science.

Professor Thorburn is co-editor with Professor Jenkins of *Rethinking New Media and Democracy and New Media*, forthcoming from MIT Press.

Professor Jenkins has also contributed a monthly column on new media to *Technology Review* and has completed seven articles on new media, film and video games this year which are forthcoming in journals and collected volumes.

Professor Ruth Perry completed a major study of the family in the English novel, *Novel Relations: The Transformation of Kinship in Eighteenth Century England*, which will be published by the University of Chicago Press. Professor Perry has also begun a new project on English and American ballads, folksongs, and the history of their preservation and transmission.

Professor Stephen Tapscott's *From the Book of Changes* (poems) was published in a new edition by Carnegie Mellon University Press in the Contemporary Classics series; he completed his translation and edition of *Gabriela Mistral: Selected Prose and Prose-Poems*, to be published by University of Texas Press, and he published articles in *Agni* and in *Theory and Praxis of Postmodernism*, ed. T. Rachwal.

Professor Hildebidle's "Letters from Ireland" is forthcoming in *Imported Bread: Literature of Cultural Exchange*, and he is revising his book of poems, *Signs, Translations*, and has started a new project, "Does Poetry Matter," a collection of contemporary poets' writings interwoven with his own commentary.

Professor William Uricchio published articles on film and media history in *Oesterreichische Zeitschrift fur Geschichtwissenschaften*, in *Archive fur Mediengeschichte-Mediale Historiographien* and in *The Moving Image: Journal of the Association of Moving Image Archivists*. In addition he has completed fifteen other articles for publication and is completing his book on German television during the Third Reich.

Associate professor Mary Fuller is working on a study of Hakluyt's Principal Navigations and published an article in *Decentring the Renaissance: Canada and Europe in Multi-Disciplinary Perspective*, ed. Germaine Warkentin.

Professor James Buzard published several chapters in edited collections, including *Disciplinarity at the Fin de Siecle*, ed. Amanda Anderson and Joseph Valente, *Being Elsewhere: Tourism, Consumer Culture and Identity in Modern Europe and North America*, ed. Shelley Baranowski and Ellen Furlough, and "Perpetual Revolution: an article on the legal, cultural and narrative history of the revolving door in *Modernism/ Modernity*.

Professor Henderson published an article on Shakespeare and the culture of theme parks in *Shakespeare after Mass Media*, ed. Richard Burt, and is completing her book *Collaborating with Shakespeare*.

Professor Raman's *Framing India: The Colonial Imaginary in Early Modern Culture* was published by Stanford University Press this year. He is completing a second book, *Untimely Meditations: Early Modern Crises of Representation*, and an article on John Donne's love poetry appeared in *Criticism*.

Professor Klein is making final revisions on her book *Cold War Orientalism*, to be published by the University of California Press, and is working on a new book on Asian martial arts in American culture.

Professor James Cain is preparing his book on 12th century statecraft and the performance of gender for publication.

Professor Jackson's article on Coleridge and "self experiment" is forthcoming in *English Literary History*.

Lecturer Kelley contributed two articles to *Melville among the Nation*, ed. Sanford E. Marovitz and A. C. Christodoulou, published this year, and her article "'Lying in various attitudes': Melville's Pip in Digital Media" will be published in the conference proceedings of the 2001 Melville Society Conference.

Literature faculty have also been active in the research groups organized by the Comparative Media Studies Program. Professor Jenkins, program director of CMS, also heads the Games that Teach research group, Professor Donaldson heads the Transforming Humanities Education group, and Professor Uricchio heads the Globalization Studies group.

Electronic Projects

The Literature Faculty has been active in the projects sponsored by the MIT-Microsoft iCampus Initiative and by the D'Arbeloff Fund for Excellence in Education. Professor Donaldson's Shakespeare Project has been awarded a third year of iCampus funding to develop a DVD-based annotation system for Shakespeare films. Professor Jenkins is principal investigator for the Games for Learning Project, also funded by iCampus.

Games that Teach will enter its second year, expanding its prototype teaching modules from science and engineering subjects to humanities-based education. Professor Jenkins also serves as director of the MetaMedia Project, which is developing a framework for sharing and annotating multimedia materials for humanities classes in literature, film, foreign languages, anthropology and other subjects. Professor Donaldson is co-PI on this project, and Lecturer Kelley's Midnight, Forecastle project on Melville was the first new "mini archive" teaching module to be completed under this initiative.

Professor Buzard, as co-editor of the international Monuments and Dust project on Victorian England, is editing 19th century issues of *Punch* for digital publication.

Professor Thorburn is editor-in-chief of the Media in Transition web site and directs the MIT Communications Forum, which this year began webcasts of its proceedings.

Professor Klein organized a web-based collaborative distance course on US-Asian Transnational Cultures with colleagues in Singapore and Bangladore, India.

Conferences and Invited Addresses

Professor Donaldson delivered a plenary address, a multimedia essay on "British Shakespeare in the Digital Age," at the inaugural meeting of the British Shakespeare Association, and a plenary presentation at SCAENA, the International Conference on Shakespeare and His Contemporaries in Performance at St. John's College, Cambridge University. He also presented a multimedia essay on Julie Taymor's film of *Titus Andronicus* at the Modern Language Association conference in New Orleans, led a session at the British Council International Workshop on Shakespeare in Performance in Stratford-upon-Avon, and spoke at the Microsoft Faculty Summit in Redmond, Washington.

Professor Kibel presented papers at the International Conference on the History of Technology in Granada and the Europe in the Twenty-First Century Conference in Edinburgh.

Professor Perry delivered the plenary address at the North Eastern Society for Eighteenth Century Studies in Halifax, Nova Scotia, and spoke at a plenary panel at the Conference on the PhD in Women's Studies in Atlanta.

Professor Tapscott gave readings of his poetry in New York, London, Toulouse, Athens, Warsaw, and Timosoara (Romania).

Professor Jenkins spoke at the Console-ing Passions Conference in Bristol, UK, the University of the West of England, the Microsoft Faculty Summit in Redmond, at SIGGRAPH in Los Angeles, the Somerville Comics Festival, the Center for Cultural Policy at the University of Chicago, the National Scholastic High School Press Association in Boston, Princeton University, New York University, Harvard, the Walker Arts Center in Minneapolis, Boston College, the Society for Cinema Studies Conference in Denver, the Electronic Entertainment Expo in Los Angeles, the Singapore New Media Conference, and the Beijing Film Academy.

Professor Uricchio spoke at INPUT (International Association of Public Service Television Producers) in Rotterdam, the European Science Foundation in Copenhagen, and the Media and European Identity Conference in Brussels.

Professor Buzard spoke at the Victorian Institute, the University of North Carolina, the Northeast Conference on British Studies in Worcester, Massachusetts, the MLA in New Orleans, and the CUNY Graduate Center.

Professor Fuller spoke at the University of Michigan and the Florida Institute of Technology.

Professor Henderson spoke at SCAENA, the International Conference on Shakespeare and His Contemporaries in Performance at St. John's College, Cambridge, and the Institute for English Studies at the University of London.

Professor Raman spoke at the SCAENA Conference in Cambridge.

Professor Klein spoke at the annual meeting of the American Studies Association.

Professor Cain spoke at the University of Massachusetts and University of Illinois.

Lecturer Kelley conducted a day-long workshop at the NEH Summer Workshop on Melville and Multiculturalism for High School Teachers and presented her "Prototype for a Web-based Curriculum for Moby-Dick there. She also spoke at the John Hopkins University, Hofstra University, and the American Literature Association.

Service

Professor Donaldson serves on the steering committee of CMS and the Council for Educational Technology. Professor Kibel directs the MIT History and Literature Workshop. Professor Thorburn serves on the steering committee of CMS, directs the MIT Communications Forum and the MIT Pleasures of Poetry discussion series. Professor Perry serves on the Gender Equity Committee for SHASS, the MIT Corporation Joint Advisory Committee, and the advisory board of the Graduate Consortium in Women's Studies. Professor Hildebidle is undergraduate officer and a freshman advisor. Professor Jenkins serves as housemaster at Senior House and is director of Comparative Media Studies. Professor Fuller serves on the HASS Overview Committee and is a freshman advisor. Professor Buzard serves on the executive committee of the Division of Anthropological Approaches to Literature of MLA and is advisory editor for ELH. Professor Henderson served as acting director of Women's Studies (fall term), and on the Committee for the Undergraduate Program, the Harold E. Edgerton Faculty Achievement Award selection committee, the Gender Equity Committee in SHASS, and the Graduate Admissions Committee of CMS. Professor Klein serves on the Austin Kelley Prize Committee and the Graduate Admissions, Curriculum, and Orientation committees of CMS. Professor Cain chairs the Literature Curriculum Committee. Professor Jackson is a planning member for the Midwest Faculty Seminars organized by the Teaching and Learning Center of the University of Chicago.

Peter S. Donaldson
Section Head
Professor of Literature

More information about Literature at MIT can be found on the web at http://web.mit.edu/lit/www/.

Music and Theater Arts

Music and Theater Arts continues to afford students at MIT the opportunity to experience the unique language and process of the arts. Faculty and teaching staff help students understand art's demand for rigor and discipline and its non-quantitative standards of excellence and beauty. A strong, comprehensive program in both Music and Theater Arts, encompassing history, theory and performance—taught by a faculty and staff of the highest caliber whose ongoing professional activities inform their teaching—has been and will continue to be our hallmark. Because it is comprehensive, the academic program continues to produce graduates who have the talent and desire to extend their education in music or theater beyond the undergraduate level.

Highlights of the Year

The MIT Symphony Orchestra, with support from the Cambridge-MIT Institute, traveled to England in May to perform a well-received program conducted by Professor Dante Anzolini. Professors Peter Child and Marcus Thompson lent their talents to the tour. Malcolm Miller for *Music and Vision* wrote, "The orchestra rose to the challenges of a formidable program which featured the U.K. premiere of *Jubal* by British born, Boston based composer Peter Child, and Penderecki's *Viola Concerto* in a stirring performance by Marcus Thompson who gave a suavely assured yet soulful account. The orchestra had a chance to display its full prowess in the final work, an invigorating and uplifting reading of Mahler's *Symphony Number 1* in which the orchestra demonstrated power and conviction in an interpretation of passion and character."

Music and Theater jointly produced a staged concert version of Purcell's *Dido and Aeneas* performed by members of The MIT Concert Choir conducted by Lecturer William Cutter. The MIT Concert Choir was also invited to perform with the Boston Pops Orchestra under the direction of Keith Lockhart.

Honors and Awards

Professor Evan Ziporyn received an ASCAP award. These awards, made by the American Society of Composers, Authors and Publishers, are given to writers of serious music based upon the unique prestige and value of each writer's catalog of original compositions.

Music and Theater was the recipient of three School of Humanities, Arts, and Social Sciences Infinite Mile Awards. The Rinaldi Tech and Design team received the Unsung Hero Award. Lecturer Cutter and Lecturer Frederick Harris both received the Outstanding Contribution to Teaching and Service Award.

Program Highlights

Enrollments in Music and Theater were 1,009 and 340, respectively, for a total of 1,349.

Music and Theater Arts continued to host the MIT Chapel Series, a successful concert series featuring local solo and group performers. The MIT Guest Artist Series hosted the Artemis String Quartet and the Vega String Quartet. The MIT American Music Series offered a series of performances focused on a range of music from American composers. Performers included the Festival Jazz Ensemble with guest conductor and composer Mark Harvey, the MIT Wind Ensemble and MIT Concert Choir directed by lecturers Harris and Cutter, composer and violinist Todd Reynolds, and composer and clarinetist Evan Ziporyn.

Music and Theater combined resources to perform the premiere of a new opera, *Coyote's Dinner*, by Music lecturer Charles Shadle and Theater senior lecturer Michael Ouellette conducted by lecturer Harris with the MIT Wind Ensemble.

Theater Arts and The Shakespeare Ensemble presented Shakespeare's *As You Like It* directed by Tom Garvey and *Winter's Tale* directed by John Hume.

Dramashop produced *Seachange*, a collective theater creation directed by associate professor Brenda Cotto-Escalera. Visiting lecturer Daniel Alexander Jones directed *One Flea Space* by Naomi Wallace. Dramashop presented an evening of student-written and student-directed one-act plays. Associate provost Alan Brody directed *Playwrights in Performance* in two evenings of one-act plays by MIT student playwrights. Senior lecturer Ouellette in conjunction with fourteen returning theater alumnae directed *Trials, Tribulations and Triumphs*. Alumnae from as far away as San Diego and Paris returned to take part in the production.

Achievements

Professor Jeanne Bamberger guest lectured at the University of Texas, Bar Ilan University in Israel, the University of South Florida, and the University of British Columbia in Vancouver.

Professor Child saw premieres of a number of new works during the last year. *Jubal* was performed by the New England Conservatory Honors Orchestra. *Bleak Light: Four Poems of John Hildebidle* was performed by Music of Changes in Los Angeles. *Prayers from the Ark* was performed by the Arcadian Wind Quintet, and *Duo* was performed by the Hirsch-Pinkas Duo at Dartmouth College. The Auros Group for New Music performed his chamber opera *Embers*. *Refrain* was performed at Tanglewood by the Indiana University Percussion Ensemble, and *Sinfonietta* was performed by the Berkshire Symphony Orchestra.

Professor John Harbison was in residence at the Tanglewood Bach Institute and the Tanglewood Composers Seminar. He received commissions from the Boston Symphony Orchestra and the Amelia Trio. *Mottetti di Montale* was recorded by Collage New Music and released on the Koch International label, and *Emerson* was recorded by the Cantata Singers and released on the New World label. He received an honorary degree from the University of Wisconsin in May. Selected performances of his works include *Symphony Number 2* with the Seattle Symphony, *Symphony Number 3* with the Munich Philharmonic, *Concerto for Oboe* with the Los Angeles Philharmonic, *Words from Paterson* with the Boston Symphony Chamber Players, and performances of *The Great Gatsby* at the Metropolitan Opera in New York City.

Professor Ellen Harris saw publication of her new book *Handel as Orpheus: Voice and Desire in the Chamber Cantatas*. She completed two articles, "Ornamentation in Mozart's Mitridate" and "Women's Voices in Handel's Cantatas." She was consultant to the Santa Fe Opera and lectured for the Boston Symphony Orchestra and Boston Baroque.

Professor Lowell Lindgren's publications include the article "An Intellectual Florentine Castrato at the End of the Medicean Era," entries in the *New Penguin Opera Guide*, and essays for *Italian Opera in Late Eighteenth-Century London, The Pantheon Opera and Its Aftermath, 1789-1795*, and *The Eighteenth Century: A Current Bibliography*.

Professor Janet Sonenberg was creative advisor for a new Broadway play, Dance of the Vampires. She was on sabbatical in the spring and is completing her next book.

Professor Thompson performed at the Seattle Chamber Music Festival, the Sitka Summer Music Festival, the Amsterdam Chamber Music Festival, and the Mainly Mozart Festival in San Diego. He did a series of performances and a recording with the Czech National Symphony Orchestra.

Professor Ziporyn performed with the Bang on a Can All-Stars in New York, and toured as soloist and composer in a performance titled *This Is Not a Clarinet*. The San Francisco Chronicle stated that Ziporyn's "suave use of extended clarinet techniques is an understated musical triumph. His piece *Partial Truths* is a vibrant little masterpiece." Two recordings Professor Ziporyn has made with Bang On a Can appeared on top ten lists compiled by music critics at *The New York Times* and *The Washington Post*.

Professor Anzolini was assistant conductor with the American Symphony Orchestra in New York. He guest conducted at the Teatro Massimo in Palermo, Italy, and with the Lincoln Center Festival in New York City.

Professor Thomas DeFrantz saw publication of his edited anthology *Dancing Many Drums: Excavations in African American Dance*. He was visiting professor at Stanford University in the spring of 2002.

Senior lecturer David Deveau concertized at Dumbarton Oaks in Washington, DC, the Mainly Mozart Festival in San Diego, and the Strings in the Mountains Festival in Colorado. He performed a series of recitals with clarinetist Richard Stoltzman in Boston, New York, and San Francisco. His chamber music performances included recitals with the Vermeer Quartet and six performances at the Rockport Chamber Music Festival. He performed with violinist Stefan Jackiw as part of the Fleet Boston Celebrity Series. He also performed a live recital on WGBH radio. He continues as artistic director of the Rockport Chamber Music Festival.

Senior lecturer Martin Marks presented the keynote paper "Convention versus Innovation in Four Nostalgic Hollywood Musicals, 1938-1942" at the Susan Porter Memorial Symposium at the University of Colorado in Boulder. He did numerous performances of the score for the film Metropolis. He performed his own scores for the movies *The General*, *The Lonedale Operator*, *The Playhouse*, and *Sherlock Jr.*

Senior lecturer Ouellette performed in *Street Scene* by Kurt Weill at the Williamstown Theater Festival. He directed Professor Child's opera *Embers* in performance with the Auros Group for New Music.

Senior lecturer George Ruckert performed concerts in California and Pennsylvania and guest lectured at New England Conservatory of Music. His Music of Southeast Asia group MITHAS produced a series of Indian music concerts, including a concert by the foremost protégé of Ravi Shankar, Arup Chattopadhyay.

Senior lecturer Pamela Wood performed solo concerts for the Schoolhouse Center Concert Series in Provincetown and the Kodaly Music Institute at Jordan Hall. She adjudicated the Price Vocal Arts Competition at New England Conservatory and continued as a faculty member at the Kodaly Music Institute at New England Conservatory for their summer program.

Lecturer Cutter was guest speaker at the eastern conference of the American Choral Directors Association. He received commissions from the New Jersey Gay Men's Chorus and the North Carolina Institute of Choral Art.

Lecturer Harris served as assistant conductor of the Boston University Young Artists Wind Ensemble and was appointed assistant conductor for the Boston University Tanglewood Summer Institute. He developed the Frank Battisti 70th Birthday Commission Project, which will commission a number of compositions from contemporary composers specifically for wind ensemble.

Lecturer Laura Harrington saw the Boston Lyric Opera premiere of her opera *Resurrection* with music by Tod Machover. The world premiere of her play *Hallowed Ground* was performed by the Portland Stage Company.

Lecturer Harvey guest lectured at Harvard University and Bowdoin College. He composed and premiered five new works with the Aardvark Jazz Orchestra with performances at Bowdoin College, the Museum of Fine Arts, and the Institute of Contemporary Art, as well as at The Regattabar in Cambridge.

Lecturer Jean Rife performed with Boston Baroque and Cantata Singers. She recorded with Boston Baroque on the Telarc label and recorded Yehudi Wyner's *Horntrio* for Bridge Records.

Lecturer Kim Mancuso directed and toured with *The House Not Touched by Death*. Her production of *Faust 2002*, which premiered at Boston Center for the Arts in April, traveled to Poland in June to be presented at the MALTA International Festival of Performance

Lecturer Elena Ruehr continues as composer in residence for the Boston Modern Orchestra Project with two new commissions to be premiered in 2003. Her composition *The Law of Floating Objects* for flute and tape was choreographed and performed by the Nicola Hawkins Dance Company as part of the Fleet Boston Celebrity Series. A new work for solo piano, *Swing Set*, was performed by Collage New Music.

Personnel

Professor Anzolini was promoted to associate professor without tenure effective July 1, 2002. Dr. Brian Robison will join the faculty as assistant professor of music effective July 1, 2002. Professor Harris will step down as section head in December of 2002, and Professor Ziporyn will become section head in January 2003.

Music and Theater Arts lost two distinguished colleagues this past year with the deaths of professor emeritus David Epstein and senior lecturer Edward Cohen.

Music and Theater Arts affirms its commitment to diversity within its disciplines and among its staff. Six members of our full-time faculty and teaching staff of 19 belong to underrepresented minorities or are women.

Ellen T. Harris
Section Head
Class of 1949 Professor of Music

More information about Music and Theater Arts can be found on the web at http://mit.edu/mta/www/.

Department of Political Science

The Department of Political Science offers a full undergraduate curriculum in political science; provides graduate education and research training at the highest level of excellence; maintains an environment in which faculty and advanced students can carry out original research on political behavior, processes, institutions, and policies; and contributes to the capacity of governmental and private organizations at the local, national, or international level to deal effectively and humanely with important political issues.

The department's mission is to create a community of men and women—senior and junior scholars, students and staff—that is rich and diverse in terms of gender, race, and national origin, all pursuing or supporting relevant and groundbreaking research and excellence in teaching.

The key to success lies in recruiting, nurturing, and retaining an outstanding faculty, devoted to both research and teaching. In the past several years, the department has successfully recruited seven new faculty (five assistant professors, two associate professors), two of whom joined us in the fall of 2001. We did not search for new faculty this past year because of involvement with a large number of promotion cases. But we did promote three colleagues to full professor, three to untenured associate, and one to tenure.

Educational Initiatives

Through our Washington Internship Program, the department is helping MIT take the lead nationally in enhancing the education of technologically sophisticated undergraduates by exposing them to the practical world of politics and policymaking, while maintaining a high degree of academic rigor. The internship program allows MIT's technically oriented students to experience how institutions vital to their later success operate, while also giving the federal government and other policymakers early access to the best young scientists and engineers in America. The program continues to expand, and 17 undergraduates will participate in the summer of 2002, the largest number in the program's history. We were able to expand participation because, in the past year, an MIT alumnus, Dana Mead, pledged a sizeable endowment to the program.

Professor Nazli Choucri continues to develop the Global System for Sustainable Development (GSSD)—an Internet-based set of experiments in international, distributed, multilingual and multicultural knowledge development, sharing and networking.

Associate professor Ken Oye organized the forum "After Pearl Harbor and 9-11: Civil Liberties Under Threat" after the tragedy of September 11, 2001. In addition, nearly all faculty who were not on leave participated in post-September 11 forums and discussions about the attack and the US response (co-sponsored by the department and the Center for International Studies). Some of these were broadcast on local television and radio stations, as well as featured on MIT web sites.

Professor James Snyder, jointly with Harvard University, co-organized the bi-weekly seminar on positive political economy and continues to oversee its operations.

Professor Charles Stewart is continuing to participate in the Residence Based Advising pilot project at McCormick Hall.

Public Policy Minor

Jointly with DUSP and Economics, the department recently established a minor in public policy. The program is now entering its fourth year, and is attracting a fair number of students to its courses. There were 15 public policy minors declared in the classes of 2002, 2003, and 2004.

New Subjects

This past year the department offered a number of new undergraduate and graduate courses. They include Science, Technology and Public Policy (taught by Professor Oye); U.S. Military Budget and Force Planning (principal research scientist at CIS Cindy Williams); Comparative Politics and China (assistant professor Edward Steinfeld); Great Power Military Intervention in Internal Conflicts: The 1990's (Professor Barry Posen); The Political Economy of Chinese Reform (Professor Steinfeld); The Political Economy of Development (Professor Steinfeld); and Organizational Theory and Military Politics (Professor Harvey Sapolsky).

Graduate Program Changes

In the spring of 2001, the faculty decided to reevaluate the Political Science graduate program. And so over the course of AY2002, the faculty's Graduate Program Committee, chaired by Professor Thomas Christensen, met to discuss improvements to the program. Its recommendations were presented to the faculty and students and were approved by the faculty in June 2002. These recommendations include a year-long seminar required of all first-year students that will touch on core issues in the principal subfields of the discipline; a second-year seminar in which students will be required to write and present a paper of publishable quality of approximately 10,000 to 12,000 words; and a shift from two general exams to one, while adding the requirement that students take at least four courses in a second field with minimal overlap with the generals field. These changes will most likely be implemented in the fall of 2003. The hope is that they will produce both greater intellectual integration and quicker transitions from preliminary requirements to thesis work.

Student Recruitment, Placement, and Enrollment

The department had a relatively good year at graduate recruitment. It received and reviewed 269 applications for the PhD program and accepted 31 applicants. The enrolling class is 14 students. This year, as in the previous year, we had a much more diverse group of students, including a large group of strong applicants in American politics, as well as a strong group in comparative politics. In the case of comparative, we made a decision several years ago to build from below in this field, and we now have a large group of excellent junior faculty. The fact that the group is so heavily junior limits graduate student recruitment. But as reputations grow and positions consolidate, I am confident that these results will change. The quality and range of interest of the fall 2002 enrolling class indicates that we are heading in the right direction.

Our graduating doctoral students continue to find positions at leading research universities and institutions, such as Dartmouth College, Johns Hopkins University, Harvard University, Princeton University, UCLA, University of Oregon, and the Naval Postgraduate School. And recent graduate Loren King had his paper selected as best paper in the Urban Section of the American Political Science Association's 2001 conference.

Undergraduate enrollments have continued to trend upward. Political Science courses experienced a 6 percent increase in enrollment in AY2002 versus AY2001 (from 932 to 985 students). And over a longer period, enrollment has increased 27 percent since 1999, while the number of undergraduate majors has inched upward: 34 in the past year, 30 in AY2001, and 27 in AY2000. There were 31 minors (Classes of 2002, 2003, and 2004) compared to 24 last year, and 54 concentrators this year versus 38 last year. These numbers suggest that the department is an increasing presence in the life of MIT's undergraduate population—which is exactly what we had hoped and expected.

Faculty Awards and Recognition

Professors Stephen Ansolabehere, Snyder and Stewart will receive the Jewell-Loehenberg Award from the Legislative Studies Section of the American Political Science Association (APSA), for the best article appearing in Legislative Studies Quarterly in 2001. The award will be given at the August 2002 meeting of APSA.

Assistant professor Kanchan Chandra was awarded a Kukin Post Doctoral Fellowship from the Harvard Academy for International and Area Studies and was on leave in AY2002.

Professor Joshua Cohen was appointed the first Leon and Anne Goldberg professor of humanities and was reappointed department head for another three-year term. Professor Cohen also was named a fellow in the American Academy of Arts and Sciences and the Romanell-Phi Beta Kappa Professor of Philosophy, 2002-2003.

Associate professor Daniel Kryder was recognized for writing the Best Book of 2000 on Historical Perspectives on Racial and Ethnic Politics by the Section on Race, Ethnicity and Politics at the 2001 APSA annual meeting.

Associate professor Chappell Lawson was awarded a Hoover National Fellowship and elected a term member of the Council on Foreign Relations. He has also been named to the Class of 1954 Career Development Professorship for a three-year term beginning in AY2003.

Associate professor Melissa Nobles' book *Shades of Citizenship* was voted in 2001 as the Best Book of 2000 by the National Conference of Black Political Scientists and received an honorable mention by the APSA Ralph Bunche Award book committee in 2001.

Associate professor Roger Petersen received an MIT/SHASS Research Grant for study in Serbia and Kosovo.

Professor Barry Posen was awarded a 2002 research fellowship from the German Marshall Fund of the United States.

Professor Richard Samuels was named the MIT Freshman Advisor of the Year, 2001-2002.

Associate professor David Woodruff was named to the Ford Career Development Professorship in Political Science, which has a three-year term.

Faculty Promotions and Recruitment

This past academic year was a very busy one for the department in terms of faculty promotions. I am pleased to report that we were very successful in this regard—and promoted the following faculty members:

Assistant professor Brandice Canes-Wrone was promoted to associate professor without tenure.

Assistant professor Chappell Lawson was promoted to associate professor without tenure.

Assistant professor Edward Steinfeld was promoted to associate professor without tenure.

Associate professor Melissa Nobles was promoted to associate professor with tenure.

Associate professor Stephen Thomas Christensen was promoted to full professor.

Associate professor Richard Locke was promoted to full professor.

Associate professor Stephen Van Evera was promoted to full professor.

In addition, Professor Charles Stewart III was appointed associate dean of the School of Humanities, Arts, and Social Sciences.

In AY2003, the department will conduct faculty searches in American politics, comparative/international political

economy, and political theory. Increasing the presence of minorities and women in the department remains a major concern. All three committees formed for the coming year's faculty searches will make special efforts to identify outstanding women and minority candidates.

Faculty Leaves, Departures, and Visitors

Several faculty members are scheduled to be on leave during the next academic year. Professor Posen is on leave for the year, and will be in Europe conducting research on European security issues. Professor Lawson also is on leave for the year. With his Hoover Fellowship, he will be conducting research on Latin American politics while at the Hoover Institution at Stanford University.

The department is losing two strong colleagues. Lecturer Margaret Burnham, who has been with the department for over a decade, is leaving MIT to join the law faculty at Northeastern University. And Professor Canes-Wrone is joining the faculty at Northwestern University

In the coming year, the department also will be hosting several visitors. They include Amherst College professor Austin Sarat, who will be teaching a course on law, violence and justice; Eric Dickson, a recent Harvard PhD, who will be teaching a game theory course; and Shigeo Hirano, also a recent Harvard PhD, who will be teaching courses in American politics in the spring.

Faculty Research, Publications, and Service

Professor Ansolabehere: co-directed the Caltech-MIT Voting Technology Project (with Professor Stewart).

Professor Berger: researched the "First Globalization," sponsored by the Centre de Recherche en Gestion/Ecole Polytechnique; The First Globalization, 1880-1914, Lessons from the French, forthcoming from Seuil.

Professor Chandra: *Counting Heads: Why Ethnic Parties Succeed in India*, forthcoming from Cambridge University Press.

Professor Choucri: "The Value of Knowledge", a two-year project supported by the Alliance for Global Sustainability; "Globalization and eBusiness," with Sloan Professor Madnick and Sharon Gillett, ITC-CTIPD; "The Technology Imperative," in the *Encyclopaedia of Politics*, forthcoming from Routledge.

Professor Christensen: studied the role of nationalism and ideology in Communist alliances in East Asia during the Cold War and the legacy of US Cold War alliances and their effect on contemporary East Asian alliances; "Beijing's View of Taiwan and the United States in 2002: The Renaissance of Pessimism," in *China Leadership Monitor*

Professor Cohen: examined issues of global justice, including human rights, democratic governance, and fair distribution of resources, with support from the Rockefeller Foundation; "For a Democratic Society," in the *Cambridge Companion to Rawls*, ed. Samuel Freeman, forthcoming from Cambridge University Press.

Professor Kryder: studied the roots and consequences of targeted racial reparations in America; "Reconsidering an American Dilemma," in *Total War and the Law*, ed. Daniel Ernst, forthcoming from Greenwood Press.

Professor Lawson: *Building the Fourth Estate: Democratization and the Rise of a Free Press in Mexico*, University of California Press.

Professor Meyer: "Dynamics of Community-based Environmental Protection," a multi-year research project funded by the National Science Foundation.

Professor Nobles: worked on a book-length manuscript on the political origins and consequences of "official apologies."

Professor Oye: researched the role of compensation strategies as mechanisms for offsetting biases toward stalemate; *Regulatory Diversity among Open Economies: Sources and Implications*, edited with Thomas Bernauer and Hideaki Shiroyama.

Professor Petersen: "Strategy and Emotion in Ethnic Conflict"; "Microfoundations of Civil War Violence" (with Stathis Kalyvas); *Understanding Ethnic Violence: Fear, Hatred and Resentment in Twentieth Century Eastern Europe*, Cambridge University Press.

Professor Posen: researched European Union security and defense policy; "The Best Defense," in *The National Interest*.

Professor Rodden: *Fiscal Decentralization and the Challenge of Hard Budget Constraints*, edited with Gunnar Eskeland and Jennie Litvak, forthcoming from MIT Press.

Professor Samuels: studied comparative civil-military relations and Japanese security policy; *Machiavelli's Children: Leaders and Their Legacies in Italy and Japan*, forthcoming from Cornell University Press.

Professor Sapolsky: studied the history of US antisubmarine warfare during the Cold War, and political constraints on US defense and foreign policy; "The Defense Industry's New Cycle,"in *Regulation* (with Eugene Gholz).

Professor Schaffer: researched the comparative politics of vote buying; "Might Cleaning Up Elections Keep People Away from the Polls? Comparative and Historical Perspectives," In *International Political Science Review*.

Professor Skolnikoff: "Will Science and Technology Undermine the International Political System?" in *International Relations of the Asia-Pacific*.

Professor Snyder: "Equal Votes, Equal Money: Court Ordered Redistricting and the Distribution of Public Expenditures in the American States," with Professor Ansolabehere and Alan Gerber, forthcoming in *American Political Science Review* .

Professor Steinfeld: "Market Visions: The Interplay of Ideas and Institutions in Chinese Financial Restructuring," submitted to *World Politics*.

Professor Stewart: studied the history of Congressional committees and the influence of the House of Representatives on the development of American political parties; co-directed the Caltech/MIT Voting Technology Project (with Professor Ansolabehere).

Professor Van Evera: "Causes of War: Misperception and the Roots of Conflict."

Professor Woodruff: "Trade Politics, Deductive Theory, and the Empirical Record: Commerce and Demolition in Tsarist and Soviet Russia," submitted to *World Politics*.

The department's faculty continues to appear at conferences, give invited lectures, and serve on boards of prestigious professional organizations and editorial boards, as well as advising government, private, and international organizations and agencies. I am confident that the number and range of these activities will grow and continue to generate further awareness of and respect for the quality of our department.

Joshua Cohen
Department Head
Leon and Anne Goldberg Professor of Humanities

More information about the Department of Political Science can be found on the web at http://web.mit.edu/polisci/www/.

Program in Science, Technology, and Society

The Program in Science, Technology, and Society (STS) marked its 25th anniversary with a day-long symposium designed to bring current faculty and staff together with STS alumni, past visitors to the program, and former faculty members. The symposium included talks on the depth and innovativeness of the current research interests of the STS faculty. After 25 years, the STS program has developed into the influential and reputable force in the academic community that its founders envisioned a quarter century ago.

Three STS faculty members will receive promotions this year—Joseph Dumit to associate professor without tenure, Evelynn Hammonds to full professor, and David Mindell to associate professor with tenure. Additionally, the second-year review of assistant professor David Kaiser was completed this year.

STS celebrated the hooding of three graduate students in June. On a less fortunate note, STS was greatly saddened by the death of Professor Walter Rosenblith this spring. Professor Rosenblith served as a source of inspiration for many people involved with the program and has left behind a great legacy at MIT. He will be deeply missed by all members of the STS community.

Doctoral Program

In its fourteenth year, the HSSST Doctoral Program (a collaborative venture of STS, the History Faculty, and the Anthropology Program) continued to develop in a satisfactory way. We are particularly pleased that three HSSST students completed their PhDs this year. Dr. Gregory Galer has been employed at Stonehill College since 1998 and is currently curator of the Stonehill Industrial History Center. Dr. Kendall Hoyt will be a postdoctoral fellow at the Belfer Center for Science and International Affairs at the Kennedy School of Government at Harvard University next year. Dr. Barbara Masi is director of education assessment for the School of Engineering at MIT. HSSST doctoral students Shane Hamilton and David Lucsko passed their general exams. Present and incoming students received a variety of grants and fellowships, including fellowships from the Dibner Institute.

The HSSST Doctoral Program received 74 applications for the 2002-2003 academic year. In total, six students accepted, among them our five top choices. One applicant selected for admission declined our offer solely for personal reasons (wanted to take time off to decide educational goals).

Projects, Grants, and Initiatives

A workshop entitled "Culture Goes Public" was organized by associate professor of anthropology and science studies Hugh Gusterson and sponsored by MIT's Anthropology Program. Fifteen anthropologists from all over the country attended the workshop to discuss how anthropologists might respond to discussions of race, globalization, war, ethnic strife, and social stratification by prominent neoconservative and neoliberal public intellectuals. The final product will be an edited volume. Funding from the dean of the School of Humanities, Arts, and Social Sciences enabled this workshop to be held.

Professor Hammonds continues her work with the MIT Center for the Study of Diversity in Science, Technology, and Medicine in the United States with funds provided by the Ford Foundation and the Andrew W. Mellon Foundation.

Professor Kaiser received an grant from the National Science Foundation (NSF) to head a 19-member workshop, "Training Scientists, Crafting Science: Putting Pedagogy on the Map for Science Studies." The workshop met in the spring of 2002 and will meet again in fall 2002 to discuss and analyze original pre-circulated papers. Following the workshop, Kaiser will edit the resulting volume.

Andrew W. Mellon professor of human development Kenneth Keniston continued his research on cultural aspects of software localization. In addition, Keniston continues to work with the Equity, Diversity, and Information Technology working group.

Professor Mindell continues his research on technology, archaeology, and the deep sea.

Abby Rockefeller Mauze professor of the sociology of science Sherry Turkle received an extension from the Kapor Foundation to continue the MIT Initiative on Technology and Self. Turkle continues "Relational Artifacts" research with support from the NSF. In addition, she has received an extension from the Spencer Foundation to continue working on the Adolescent, Technology, and Identity conference, which will result in the publication of a series of papers.

Robert M. Metcalfe professor of writing Rosalind Williams received a grant from the NSF to form a working group "Rethinking Information Technology after September 11." The working group met for two days in the Spring 2002 to discuss the implications for research, education, and public engagement among historians and social scientists in technology studies following the events of September 11 and their aftermath.

Educational Activities

The STS Program offered 21 undergraduate subjects and 22 graduate subjects in AY2002. Undergraduate enrollment totaled 347 (fall 170; spring 177). Graduate enrollment totaled 158 (fall 104; spring 54). (Note that actual

enrollments are somewhat higher, as our "joint" subjects reflect only the students who registered under the STS number.)

STS currently has 3 undergraduate majors, 2 minors, and 27 concentrators.

Freshman advisor seminars were offered by associate professor Deborah Fitzgerald (Viewing the Industrial Revolution in Boston) and Professor Evelyn Fox Keller (Thinking about One's Self). Undergraduate seminars were offered by Dr. Stiefel (Engineering in the Real World) and visiting lecturer Aaron Brody (Maritime Technology and Society in the Ancient Mediterranean). Two of our doctoral students taught very successful undergraduate reading seminars: Mr. Lucsko, The Automobile in America (enrollment: 16); and Mr. Kaushik Sunder Rajan, Writings about Biomedicine: Law, Ethics, and Practice (enrollment: 7).

New STS classes for 2001-2002 included the graduate subjects "Is Technology Eradicating Nature?" (Professor Williams and the emeritus Kenan professor of American cultural history, senior lecturer Leo Marx); the joint STS/HST "Social Studies of BioSci and BioTech" (Professor Michael Fischer, with Harvard University professors Byron and MaryJo Good); and the undergraduate subject "Industrial Landscapes" (Professor Fitzgerald).

Professor Keniston's "Introduction to India" class prepared three undergraduates for summer internships in India as part of the MIT India Program, which he directs. Professor Kaiser continues to offer the writing workshop for HSSST doctoral students that he began last year. The sessions provide informal opportunity for students to get feedback from their peers on conference papers, potential articles, and dissertation chapters.

The STS Program received approval from the HASS Overview Committee to designate three existing subjects as HASS Communication Intensive (CI-H). They are STS.001 Technology in American History (Leverett Howell and William King Cutten professor of the history of technology Merritt Roe Smith); STS.002: Toward the Scientific Revolution (Professor Kaiser); and STS.042 Einstein, Oppenheimer, and Feynman (Professor Kaiser). That brings STS's CI-H total to five subjects. STS.042 was also approved as a Communication Intensive-Major (CI-M) requirement for the 8B track in the Physics Department.

Special Events

The STS Program commemorated its 25th anniversary with a symposium on October 31 that represented the broad interests and involvement of the STS faculty. The celebration featured seven different STS presenters in two sessions. The wide range of topics touched on by the symposium speakers sought to integrate knowledge across the very different fields of science and engineering and humanities and social sciences—a goal which has served as the very basis of the STS program since its inception in 1976. Lecturers included Professors Dumit, Fitzgerald, Gusterson, Hammonds, Kaiser, Mindell, and Turkle. The day-long symposium was followed by a reception at the MIT Museum.

This year's Siegel Prize for the best work by an MIT student in Science, Technology, and Society was awarded to HSSST graduate student Eden Miller for "Designing Freedom, Regulating a Nation: Socialist Cybernetics in Allende's Chile." Ms. Miller is a student in the History and Social Study of Science and Technology doctoral program whose interests are primarily in the history of computing. She is an electrical engineer, with an undergraduate degree from Princeton, who is now doing research in 20th century information technology. The committee was impressed with the quality and depth of the submissions received for this year's Siegel Prize competition from students in MIT's departments and programs. The number of submissions jumped from 8 last year to 25 this year, an impressive increase.

Professor emeritus Charles Weiner delivered this year's Annual Arthur Miller Lecture on Science and Ethics on May 6, 2002. Professor Weiner's research, writing, and teaching focus on the political, social, and ethical dimensions of contemporary science and the involvement of scientists in public controversies arising from their work. Professor Weiner's Miller Lecture was entitled "The Troubled Helix: Ethical Conflicts and Political Choices in the New Biology. Historical Perspectives on the Current Crisis."

Colloquia Series and Special Lectures

The STS Colloquia series, headed this year by Professor Smith, brought 10 speakers from institutions such as the University of California at Berkeley, MIT, Harvard University, Rice University, and the Institute for Energy and Environmental Research. A wide range of topics was covered, including "The Digital City: IT as Process and Globalization as Outcome," "Can Eugenics Be Morally Right and Politically Correct? The Case of Thalessemia Screening in Cyprus," "Hydrology as Myth and Science: The American Experience," "Everything Begins in the Ocean – Including Science," and "Three Roots of Human Recency: Molecular Anthropology, the Refigured Acheulean, and the UNESCO Response to Auschwitz."

Another important event, the 2002 Morison Prize Lecture, was delivered on May 2, 2002, by Daniel Callahan of The Hastings Center and was entitled, "Saving Ourselves from Ourselves: The Uses and Limits of Technology."

Knight Science Journalism Fellowship Program

Now entering their twentieth year, the Knight Fellowships continue to attract science journalists from around the world to learn more about the science and technology they cover. During his fourth year as director of the program, Boyce Rensberger organized a week-long intensive fellowship on molecular biology for science journalists, as well as a five-day intensive fellowship on medical evidence.

The twentieth class of fellows includes Pamela Asigi Andiba, senior reporter for Nation Broadcasting, Kenya; Ruth Helena Bellinghini, science reporter and assistant editor for O Estado de S. Paulo, Brazil; Chen May Yee, reporter for *The Asian Wall Street Journal*, Malaysia; Alessandro Greco, freelance science writer, Brazil; Trisha Gura, freelance science writer, chiefly for *Science*, *Nature* and *New Scientist*; Annalee Newitz, culture editor of the *San Francisco Bay Guardian*; David Paterson, producer of science and medical documentaries, England; Adam Rogers, general editor for *Newsweek*; Lauren Slater, freelance journalist, award-winning author of *Welcome to My Country*, *Prozac Diary*, *Lying*, and *Love Works Like This*; Clive Thompson, Canadian freelance writer and producer, columnist for *Canada's Report on Business* magazine, editor at large for *Shift* magazine, and a frequent commentator on the Canadian Broadcasting Corporation.

Fellows attend over 60 seminars with faculty, which are specially organized for them, as well as other seminars and workshops devoted to science and technology and their wider impacts. The fellowships are supported by an endowment contributed by the John S. and James L. Knight Foundation of Miami and by alumni and foundation gifts.

More information about the Knight Science Journalism Fellowships can be found at http://web.mit.edu/knight-science/.

Professional Activities

Professor Fischer published the articles "Filmic Judgment and Cultural Critique: The Work of Art, Ethics, and Religion in Iranian Cinema" in *Religion and Media*, edited by Hent de Vries and Samuel Weber; "In the Science Zone: The Yanomamo and the Fight for Representation" in Anthropology Today; and "Ethnographic Critique and Technoscientific Narratives: The Old Mole, Ethical Plateaux, and the Governance of Emergent Biosocial Polities" in *Culture, Medicine, and Psychiatry*. He served on the HSSST PhD admissions committee and on the HASS AI and Middle East Working Group on New Methodologies for Terror Reduction. Professor Fischer attended the National Academy of Sciences of Iran and US National Academies of Science, Engineering, and Institute of Medicine conference and the American Anthropological Association Meetings in Washington, DC. Professor Fischer serves as advisor to six HSSST graduate students, is on two thesis committees, and serves on a PhD dissertation committee in the Department of Architecture.

Professor Fitzgerald organized and co-chaired (with Professor Harriet Ritvo) the Mellon Foundation Sawyer Seminar called "Modern Times, Rural Places," which brought 15 speakers to the program for lectures and meetings with graduate students. She was chair of the Committee on Academic Performance and chair of the Gender Equity Committee for SHASS (co-chair with Professor Jean Jackson for part of the year). She was also a member of the MIT Museum's Collections Committee and a freshman advisor. Professor Fitzgerald introduced a new undergraduate class, Industrial Landscapes, and published an article, "Accounting for Change: Modernity and Agriculture," in Robert Johnston and Catherine Stock's *The Countryside in the Age of the Modern State*. Her book *Yeoman No More* is forthcoming from Yale University Press.

Professor Gusterson published the articles "The McNamara Complex" in *Anthropological Quarterly*, "Elites: Anthropology of" in *The International Encyclopedia of the Social And Behavioral Sciences*, "An Hour With Noam Chomsky" in *Interventions*, and "Tall Tales and Deceptive Discourses" in *The Bulletin of the Atomic Scientists*. He was also program chair for the annual meeting of the Society for Social Studies of Science (4S), a 4S council member, and treasurer of the American Ethnological Society, as well as serving on selection committees for the National Science Foundation and MIT's Knight Science Journalism Fellowship Program. Professor Gusterson was named the next director of graduate studies for the HSSST Doctoral Program.

Professor Hammonds continued as secretary of the MIT Faculty; served on the Council on Faculty Diversity and the Task Force on Minority Student Achievement; co-authored the *Reports of the Committees on the Status of Women Faculty at MIT*; served on three doctoral dissertation committees; organized for the sixth year the Joint MIT/Harvard Workshop on "Race" in the Histories of Science, Medicine and Technology; continued research on two book projects; gave twelve invited lectures, including the centennial lecture of the Wadsworth Research Center of the New York State Department of Health; presented papers at three national conferences, including three invited papers at the annual meeting of the Society for the Social Studies of Science; and served on one NSF review panel for the ADVANCE Program. She was named a Sigma Xi Distinguished Lecturer by Sigma Xi, the Scientific Research Society. She served as a consultant to the Association of American Colleges and Universities, Spelman College, and the Woodrow Wilson Foundation; served as a member of the Higher Education Panel of the Building Engineering and Scientific Talent Project (BEST);

served as a consultant on three film projects (two on race and science); served on the program committee of the Berkshire Conference of Women's Historians. Professor Hammonds led three research workshops on race and/in the history of science, medicine and technology during the spring term, with a total of 50 scholars attending. Professor Hammonds organized the National Initiative on Minority Women Scientists and Engineers meeting which was held at MIT, January 18-19, 2002.

Professor Kaiser has been preparing two edited volumes for publication, and completed three articles for publication. He delivered five invited lectures and colloquia across the country, and three lectures at national conferences. He also hosted the first of a two-part international conference at MIT on the history of the physical sciences. During the year, he received research grants from NSF and the Spencer Foundation, with the aid of which he is currently completing his first book.

Professor Keller was awarded a medal from the Italian Senate in October 2001, was a Moore Scholar at Caltech during the spring 2002 semester, and received a Dibner Fellowship for spring 2003. *Making Sense of Life* appeared in April, and *The Century of the Gene* was translated into German, Italian, Portuguese, Korean, Japanese, and French. She also had three new articles appear in edited volumes.

Professor Keniston was Sir Ashutosh Mukerjee visiting professor at the National Institute of Advanced Studies at the Indian Institute of Science in Bangalore from September 2001 through January 2002, and lectured at a number of Indian institutions, including IIT-Chennai, IIT-Mumbai, IIT-Kanpur, Administrative Staff College of India-Hyerabad, and private firms. During that period, he delivered the Second M.N. Srinivas Memorial Lecture, "IT for the Common Man." Professor Keniston focused his research on information technology, examining such topics as Indic language software and, more recently, on Indian projects and research to close the "digital divide" within India and between India and the so-called Northern nations. With department head Professor Ashok Jhunjhunwala (Indian Institute of Technology) and Deepak Kumar (Dy Editor, Software diOxide), he is currently editing a book called *Bridging the Digital Divide: Lessons from India*, which will be published by Sage (Delhi) in 2002. Professor Keniston directed the MIT India Program, whose long-term goal is increasing the presence of India on the MIT campus. In addition to teaching two STS courses this spring, he also organized the 2002 Morison Prize and Lectureship in Science, Technology, and Society.

Professor Mindell's book *War Technology, and Experience* aboard the USS Monitor was awarded the Sally Hacker Prize from the Society for the History of Technology for the best book in the field accessible to students and a popular audience. His paper "Opening Black's Box: Rethinking Feedback's Myth of Origin" was awarded the IEEE Life Member's Prize in Electrical History by SHOT as well. Mindell was also awarded a $200,000 grant from the Ocean Exploration Program of the National Oceanographic and Atmospheric Administration for advanced development of autonomous underwater vehicles for archaeological exploration in deep water. Mindell's "DeepArch" research group held its second conference this spring on "Technology, Archaeology, and the Deep Sea," which was attended by archaeologists, engineers, oceanographers, and policy makers from around the world, discussing the emerging new science of deep sea archaeology.

Professor Smith's book *Inventing America: A History of the United States* was completed this spring and is expected to be widely used by next fall. He served as a member of the HSSST Doctoral Program's graduate admissions committee, the board of advisors for the MIT Museum, and the Lemelson-MIT Prize and Lifetime Achievement Award committee. Professor Smith presented several public lectures over the past year, including "Army Engineers and the Industrial Revolution in America" at the US Military Academy, "War, Technology, and Economy: Rethinking the Origins of the Industrial Revolution in America" at the University of Colorado—Boulder, and "A Deadly Invention: The Impact of Rifled Weaponry in the American Civil War" to MIT alumni and other travelers aboard the Mississippi Queen. In addition, he served on the visiting committee for the School of History, Technology and Society, Ivan Allen College, Georgia Institute of Technology. He was primary advisor to two students, served on the dissertation committees for another two students, and was a general examination committee member for three different graduate students. Professor Smith will be stepping down as director of the STS Program on July 1, 2002.

Professor Turkle worked as the director of the MIT Initiative on Technology and Self. Among the activities of the initiative during this past year were an ongoing open workshop series on "Evocative Objects," focusing on specific objects that cause us to think differently about categories like self, other, intention, desire, emotion, the natural, the artificial, and the body. Some of the Evocative Objects presentations of AY2002 have explored robotic toys, wearable computers, digital archives, and Prozac pills. Mitchell Kapor, a major donor, presented an Evocative Objects workshop on "Lindenworld," his new virtual community. The initiative also sponsors working groups in specific thematic areas. Current working groups include: adolescence, technology, and identity; psychopharmacology and identity; design, space, and software; and robotic creatures and human identity. Next year there will be new working groups in nanotechnology and self, information

technology and professional identities, the archive: physical and digital, gender, technology, and identity, and psychodynamic issues in digital culture. Both the Evocative Objects workshops and the working groups have drawn students, faculty and staff participation from across all schools of the Institute. Professor Turkle received funding from the NSF for research on relational artifacts and is conducting ongoing research in the area of robotics, digital pets, and simulated creatures, particularly those designed for children and the elderly.

Professor Williams served as director of graduate studies for the History and Social Study of Science and Technology (HSSST) Doctoral Program. She completed her book manuscript *Retooling: A Historian Confronts Technological Change*, which will be published by the MIT Press. She also helped MIT respond to 9/11 by organizing a teach-in in October, an IAP activity on implications for MIT's educational mission, and a workshop in March, sponsored by the NSF, on "Rethinking Technology after September 11," as well as publishing a comment in Technology and Culture ("A Technological World We Can Live In"). She is also chairing the finance committee for the Society for the History of Technology. Finally, on the day after commencement she was made an honorary member of the Association of Alumni and Alumnae of MIT. Professor Williams will become director of the Program in Science, Technology, and Society on July 1, 2002.

Merritt Roe Smith
Director
Cutten Professor of the History of Technology

More information about the Program in Science, Technology, and Society can be found on the web at http://mit.edu/sts/.

Program in Writing and Humanistic Studies

The Program in Writing and Humanistic Studies (PWHS) teaches and encourages MIT students to write with force, clarity, and creativity in a wide range of forms. Students write fiction and poetry. They write essays and journalism. They do technical writing. They write for electronic media. And they study the forms, techniques and traditions that bear upon each of these genres.

The members of our program include scholars, journalists, and artists who themselves write in these areas, and who publish research in a variety of humanistic fields, both traditional and interdisciplinary. The faculty includes joint appointments in History; Science, Technology, and Society; Physics; and Mechanical Engineering. Program members work in three different contexts: (1) in the core academic curriculum, made up of SHASS distribution subjects and electives, (2) in writing-across-the-curriculum outreach programs throughout the Institute, and (3) in the Writing and Communication Center.

Program subjects during the past year enrolled 1,330 students, of whom 12 were majors, 32 were minors, and 139 were concentrators in writing for the SHASS requirement. Our writing-across-the-curriculum programs brought writing instruction to more than 1,500 students in departments throughout the Schools of Science, Engineering, and Architecture. Finally, our Writing and Communication Center staff assisted a total of 701 clients for a record total of 3,134 visits, providing assistance with reports, papers, oral presentations, and thesis projects.

Research and Publications

Professor Anita Desai published articles in an anthology on bilingualism and in *Preservation Magazine*, and she continued work on a new novel.

Professor Alan Lightman continued work on a new novel, titled *Reunion*.

Professor Robert Kanigel's popular history of travel and tourism, *High Season*, was published by Viking in June of 2002. A Chinese translation of his *Apprentice to Genius* appeared in 2001, and he has begun preliminary research on a book, *Crocodile Dreams*, about leather, imitation leather, and the boundaries between the natural and the manmade.

Professor Kenneth Manning continues research on a study on the role of African Americans in medicine and on an encyclopedia of African Americans in science, technology, and medicine.

Professor Cynthia Wolff continues work on a literary biography of Willa Cather.

Professor James Paradis continues work on a study of Samuel Butler and nineteenth-century science.

Associate professor Helen Elaine Lee is currently working on a novel about prison and prisoners' lives.

Adjunct professor Joe Haldeman's science fiction novel *The Guardian* will be published by Ace Books in December 2002.

Senior lecturer Edward Barrett continues work on a new study on the poetics of cyberspace. A collection of his new poetry, *Sheepshead Bay*, was published by Zoland Books in October 2001.

Writer-in-residence Stephen Alter's work *Sacred Waters: A Pilgrimage Up the Ganges River to the Source of Hindu Culture* was published by Harcourt Brace in October of 2001, and his co-edited Penguin *Book of Indian Short Stories* also appeared in October. He continues research on a new volume, *Elephas Maximus: a Biography of the Indian Elephant.*

Lecturer William Corbett's *All Prose: Selected Essays and Reviews* was published by Zoland Books in October 2001.

Lecturer Rebecca Faery is conducting research on captivity narratives in American cultural history and on a collection of essays on Vietnam.

Dr. Susanne Klingenstein is working on two new books, *The Integration of the Holocaust into Germany's Cultural Memory* and *The Art of Medicine: A Literary Anthology.*

Lecturer Karen Boiko's paper on audience and Samuel Smiles's early career is forthcoming in Nineteenth Century Prose.

Lecturer Kim DeVries's paper "Creating and Delivering Multimedia Content for Asynchronous Courses" appeared in the *Proceedings of Computers and Advanced Technology in Education.*

Lecturer Elizabeth Fox continues her work on D. H. Lawrence, published several review essays, and delivered a paper in Siena, Italy.

Lecturer Erica Funkhouser published a volume of poetry, *Pursuit*, with Houghton Mifflin in April 2002.

Dr. Leslie Perelman, director of Writing Across the Curriculum, is serving as principal investigator for the TestWrite Project, funded by the MIT-Microsoft I-campus partnership. This initiative is developing a national consortium of universities to develop innovative and educationally valid tests over the World Wide Web.

Lecturer Christopher Sawyer-Lauçanno published a book of poems, *Les Mots Anglais*, and continues work on his biography of E. E. Cummings.

Lecturer Ann Snodgrass published a volume of critical essays, *Knowing Noise: The English Poems of Amelia Rosselli*; a volume of poems, *Portal*; and has a forthcoming book of translations from the Italian, *The Hippopotamus.*

Academic Programs and Initiatives

The Program in Writing and Humanistic Studies is supporting three major SHASS initiatives at the Institute: (1) the Communication Requirement, (2) the Comparative Media Studies Graduate Program, and (3) the Graduate Program in Science Writing.

The new Communication Requirement, which was approved last year by the faculty, will be implemented with the arrival of the Class of 2005. The new requirement replaces the old proficiency-based Writing Requirement with a new, instructionally based requirement: every undergraduate must take some form of instruction in writing and speaking each year of his or her four-year program. Roughly 20 percent of incoming MIT freshmen are now required, on the basis of their performance on the Freshman Essay Evaluation test, to take an expository writing class. Dr. Rebecca Faery, director of First Year Writing, has undertaken a program of redesigning our first-year expository writing curriculum, and over the past two years has completed an extensive training program for our first-year writing instructors. This program has been successful in improving the standards, interest, and consistency of our expository writing subjects. It has also introduced new elements of oral communication to the traditional subject matter.

As part of instituting the new Communication Requirement, we have also revamped and expanded our writing-across-the-curriculum (WAC) programs. The object of these decentralized programs is to take writing instruction and evaluation into core subjects of science and engineering departments throughout the Institute. Two years ago, the Office of the Writing Requirement moved from the Office of the Dean of Students to PWHS, where Dr. Perelman and Ms. Madeline Brown assumed the respective duties of director of Writing Across the Curriculum and coordinator of Writing Initiatives. Dr. Perelman and Ms. Brown have expanded the WAC teaching efforts of PWHS throughout every department at the Institute (except the Sloan School), and they have experimented extensively with innovative instructional programs.

In preparing for the Communication Requirement, we have strengthened the Writing and Communication Center. This PWHS facility dealt with a record number of visits (a 5 percent increase over last year). Anticipating an increased demand on the center's resources, the center's director, Dr. Stephen Strang, integrated several new tutoring strategies into the center's activities, including special practice seminars on oral communication, an Online Center, an online tutor (which accepts writing samples of up to 1,000 words and was consulted 60 times), and an extended hours program in the evenings and on weekends.

The second major initiative of PWHS has been its collaboration with the Foreign Languages and Literatures section and the Literature Faculty to support the Comparative Media Studies Graduate Program (CMS). The three sections continue to pool resources, collaborate in developing an interdisciplinary graduate curriculum, share in the advising of graduate students, and jointly govern the policy of CMS. Dr. Barrett, who teaches the writing in digital media subjects in PWHS, taught two subjects taken by CMS students: the CMS Workshop (CMS.950) and Writing in Cyberspace (21W.785). In addition, the PWHS head was a member of the governing board for CMS, which met regularly throughout the year to set policy and make decisions. Faculty of PWHS will also serve on search, curriculum, and other administrative committees of CMS.

PWHS's third major initiative, the Graduate Program in Science Writing, over the past year hired a new graduate administrator, Sarah Merrow-Arista; moved into new quarters; designed a poster that went to more than 6,000 departments and faculty around the country; established a web site; put out a brochure; and otherwise worked at promoting the program. In its first year, up to the application deadline in February, it received almost 500 inquiries from prospective students. Across the year, faculty worked to conceive and establish standards and create syllabi for the fall and spring Advanced Science Writing Seminars, and for Thesis Seminar, both of which are new subjects for the graduate program. It formed an admissions committee, which included faculty from STS and CMS, that selected, from an applicant pool of 40, its first entering class of seven students. Professor Kanigel, director of the graduate program, has worked over the past year with Professor Lightman, Dr. Boyce Rensberger (head of the Knight Fellows Program), Professor Manning, Lecturer B. D. Colen, and Professor Paradis. A search for an additional faculty member is underway.

Service, Grants, and Awards

Professor Desai received an honorary degree from Amherst College. Professor Lightman gave the Hart House Lecture at the University of Toronto and the Honors convocation lecture at Texas Christian University. Professor Paradis was a visiting fellow at Clare Hall, Cambridge University, in the spring of AY2002. Writer-in-residence Alter received a John Simon Guggenheim Memorial Foundation Fellowship and lectured at the Banff Centre of Mountain Culture in Banff, Alberta. Dr. Barrett received a Massachusetts Cultural Council Grant for poetry and gave the Phi Beta Kappa Commencement Day Address at Brooklyn College for 2002. Lecturer Funkhouser was elected a Literary Light for 2002 by the Associates of the Boston Public Library. Lecturer DeVries lectured on "Cultural Stereotypes and Academic Discourse" at the University of Hong Kong. Lecturer Faery chaired a panel and presented a paper on

"Creative Writing and Composition" at the Associated Writing Programs National Conference in New Orleans. Dr. Perelman chaired a panel and delivered a paper on the new MIT online assessment tool at the Conference on College Composition and Communication. Lecturer Andrea Walsh led a seminar on Race, Class and Gender in Nineteenth-Century Women's Activism at the Harvard School of Education. Lecturer Snodgrass gave a series of lectures in Rome on Holocaust authors.

Personnel

Professor Desai retired from teaching at the end of the spring term of AY2002. The program has hired fiction writer Junot Diaz as a new associate professor of writing. Professor Paradis will head the program for the next two years. Professor Manning will be on sabbatical leave and Professor Wolff will be on professional leave in the spring of AY2003.

With respect to diversity, women are 59 percent of our total teaching staff and 33 percent of our core faculty. Minority members are 7 percent of our total staff and 23 percent of our core faculty. Two members of our teaching staff—an associate professor and a full professor—are African American.

James Paradis
Section Head
Professor of Scientific and Technical Communication

More information about the Program in Writing and Humanistic Studies can be found on the web at http://web.mit.edu/humanistic/www/.

Center for International Studies

The Center for International Studies (CIS) at MIT is dedicated to generating the knowledge, skills, and leadership needed to address an increasingly more complex international political and economic environment. CIS focuses on the critical role of international education in science and technology in the transformation and future conduct of foreign affairs and commercial diplomacy. At CIS, we are also seeking new ways that the social sciences, in conjunction with emerging technologies, can be brought to bear on public policy. The quest for this new knowledge, along with a range of unresolved problems—from regional financial crises and nuclear confrontation in Asia to widespread ethnic conflict and structural poverty—are the main forces driving MIT to increase significantly its efforts in internationally oriented research and education.

Following the terrorist attacks of September 11, 2001, CIS conducted two public forums to help the MIT community gain some perspective on the catastrophic events that had occurred. The first was held on September 12, and the second on September 17. CIS then assumed responsibility as lead organizer for six MIT "teach-ins" on the crisis:

United States and International Media Coverage—September 20

International Student Perspective—September 24

Technology, War, and Terrorism—October 1

United States Policy Options—October 4

Economic Implications of the Crisis—October 11

Middle Eastern Perspectives—October 15

These events were held under the auspices of and in conjunction with the School of Humanities, Arts, and Social Sciences, and were sponsored by the provost's office.

Richard J. Samuels, Ford international professor of political science, continued as the center director and as the acting director of the MISTI Program. Associate professor Stephen Van Evera remained in his role as associate director. Dr. William W. Keller continued to serve as CIS executive director and research director of the MIT Japan Program.

Fiftieth Anniversary

In May 2002, CIS celebrated its fiftieth anniversary. At the dinner celebration, Dean Philip Khoury announced a gift to CIS endowment of $10 million from the C. V. Starr Foundation, and Director Samuels announced a gift of $2 million from Robert Wilhelm to establish the Wilhelm Distinguished Visitor program. The following day CIS held a symposium featuring four panel discussions on salient issues of our times in which CIS—its faculty, staff, and researchers—had played important roles:

Research and the National Interest

Conflict in the Twenty-first Century

Human Rights and Justice

Global Education and Its Significance in the New Century

Professor emeritus Donald L. M. Blackmer wrote a retrospective monograph, The MIT Center for International Studies: The Founding Years 1951–1969, to mark the occasion of the center's fiftieth anniversary.

The Starr and Wilhelm gifts to CIS that were announced at the anniversary will immediately enable the development of three programs.

Starr Asia Fellows Leadership Project

Within the next decade, it is likely that the aging leadership in China, Japan, Malaysia, Korea, and elsewhere will be replaced by a younger generation of leaders. It is in the national interest that new leaders in Asia establish close ties to the United States. The Starr Asia Fellows Leadership Project, run jointly by the Security Studies and MISTI programs, will permit a highly select group of future Asian military, business, and government leaders to work closely with Americans who have returned from Asia to continue their social science and technological studies at MIT. Assistant Professor Edward Steinfeld is project director.

CIS Starr Forum

Through its scholarly conferences and publications, the Center for International Studies has long helped shape academic and public discourse on critical issues of world affairs. Its work has been especially influential in the academy and the policy community. In the past, however, broad public visibility was subordinated to academic and policy-related activities. The center has recently established a systematic program of outreach in the form of CIS Forums to present research results and spirited debate to a wider national and international audience. Professor Van Evera directs the Starr Forum.

Wilhelm Visiting Fellowship in International Studies

Beginning in 2003, the Center will house each year a distinguished visitor with extensive experience in government. While in residence at CIS, the Wilhelm Visiting Fellow will write and reflect on critical issues of international affairs, engaging the academic community across the Institute.

CIS includes 160 members of the MIT faculty and staff, and visiting scholars from other institutions, many from abroad. It is organized into formal programs, working groups, and individual research projects. Programs engage

in a broad range of research and training activities related to their substantive concerns. Multidisciplinary working groups bring faculty, research associates, and students together around shared interests. Faculty members and research staff also conduct their own research projects under the auspices of the center.

MIT Security Studies Program

The MIT Security Studies Program (SSP) is a policy research and teaching component of the MIT Center for International Studies. It focuses on the security concerns of states. SSP has over 40 associates, including more than a dozen faculty members who devote essentially all of their professional attention to security issues. About half of the program's faculty members are natural scientists and engineers and half are social scientists, thus giving the program a strong interdisciplinary flavor. Forty-eight graduate students are affiliated with the program, nearly all of whom are doctoral candidates in political science. In addition, more than 20 fellows are attached to SSP, including military officers from each of the armed services who receive war college credit for time spent at MIT, scientists and engineers from several countries who work on missile defense and nuclear weapons issues, and several senior scholars and former government officials.

Program research is built around the interests of the faculty, the dissertations of the graduate students, and occasional commissioned projects. The research categories are best expressed in a listing of the program's working groups—faculty led research teams that focus on the same general topic. There are six such groups:

Conventional Warfare Working Group—led by Professor Barry Posen, a political scientist noted for his work on grand strategies, military innovation, and, more recently, ethnic conflict.

Defense Technologies Working Group—directed by principal research scientist George Lewis, a physicist, and one of the program's associate directors, and Professor Theodore Postol, a member of the MIT Science, Technology, and Society Program and a nuclear engineer.

Defense Politics Working Group—chaired by Professor Harvey Sapolsky and principal research scientist Owen Cote, associate director of the program, also examines civil/military and interservice relations.

Future of the Defense Industries Working Group—chaired by Professor Sapolsky, focuses on life after the Cold War for defense contractors and arsenals in both Europe and the United States.

Humanitarian Intervention Working Group—offered jointly with Harvard and chaired at MIT by Professor Van Evera, a member of the Political Science Department and an international relations theorist.

Space Policy Working Group—led by Professor Daniel Hastings of the MIT Aeronautics and Astronautics Department and former chief scientist of the Air Force.

Each year the program sponsors four to six conferences, including a conference jointly organized with Harvard on the future of war); an annual conference on airpower topics, named after MIT graduate General Jimmy Doolittle (USAF); and another on nuclear weapons, named after Vice Admiral Levering Smith. Summaries of program conferences are widely distributed.

In addition to conference summaries, the program publishes a research journal, Breakthroughs; a seminar summary series, "SSP Seminars"; a monthly newsletter, *Early Warning*; and a working paper/occasional paper series. These are distributed via the Internet and a large mailing list. Several Breakthroughs articles have been reprinted by other publications and several working papers have been adopted for courses at other universities.

MIT International Science and Technology Initiative

MISTI, the MIT International Science and Technology Initiative, creates and supports programs that promote the internationalization of education and research at MIT. MISTI/China was launched in 1994, the first of a projected series of regional programs to enhance the ability of MIT students to acquire a deeper understanding of how knowledge is created and used in other countries. It also provides opportunities for MIT researchers to develop international collaborations with scientists and technologists at outstanding foreign institutions.

The principal objective of these collaborations is to expand core resources for studying other societies on campus and to share a growing MIT base of knowledge about foreign science, technology, and industry through outreach programs in the United States. Today MISTI has three programs in Asia: China, India, and Japan; and three in Europe: Germany, Italy, and France. The mandate of all the programs is to educate MIT scientists, managers, and engineers in the language and culture of the country before placing them in "hands on" internship situations in the host country. The internship program has two primary objectives: to launch students in their careers by fostering international skills and expertise, and more broadly,to develop a cadre of internationalists—specialists in technology and management—who can strengthen interaction and communication with Japan and East Asia.

The programs also conduct meetings, symposia, and workshops and produce and disseminate research on

pertinent topics. MISTI works closely with sponsors on all the above programs and produces a biannual resume book.

MIT China Program

China was the first focus of the MISTI program, offering opportunities for student internships in mainland China, Taiwan, and Hong Kong. Students work at public service organizations, laboratories, and multinational corporations in Greater China. The program facilitates collaborations between MIT and outstanding Chinese universities and laboratories. Students are placed in diverse host institutions such as Tsinghua University, Fudan University, Intel Corporation, IBM, Microsoft, Roche Pharmaceuticals, General Motors, the United Nations, the World Wildlife Fund, and many others. More than 50 MIT students are now sent to Greater China on internships each year.

MIT-China Educational Technology Initiative

In 1997, MISTI sponsored a new student internship program: the MIT-China Educational Technology Initiative. The mission of MIT-CETI is to build cross-cultural understanding between Chinese and American students through the development of computer-related educational projects. Five teams of three MIT students are sent to Chinese high schools each year for six-week summer projects. Since President Clinton's visit to a CETI Internet project in China in 1998, the CETI curriculum has expanded into other technical areas such as web design, desktop editing, digital imaging, robotics, biotechnology, and e-commerce.

MIT France Program

The MIT France Program started in September 2000 as MISTI's sixth country program. Built on the MISTI model, the MIT France Program aims to bring understanding of the accomplishments and problems of contemporary France to the attention of the students and faculty of MIT. In order to build long-term networks of cooperation between MIT and France, the MIT France Program is setting in place three main components:

> Internships for students and recent graduates in companies and research laboratories in France: 17 MIT students were placed in France in the program's first year. Five more students studied in France in 2001-2002.
>
> Doctoral and postdoctoral fellowships for young MIT researchers to conduct research in France's leading laboratories.
>
> Visiting positions for French professors or researchers in various MIT departments

With recent support from the French Ministry of Foreign Affairs, the MIT France Program has added a fourth component: jumpstarting new collaborative projects between MIT and France which encourage multidisciplinary approaches in education, research, and technological innovation

MIT Germany Program

In 1996, MISTI launched the MIT Germany Program. It provides internship opportunities for undergraduate and graduate students to combine their knowledge of German language and culture with their expertise in the fields of engineering, science, and management. Sending about 40 students each year, the program has placed about 240 MIT students in German companies and research and government institutions, including BMW, Bosch, DaimlerChrysler, Infineon Technologies, Siemens, the Max Planck Institute, and the German Parliament. It has also placed about 30 visiting students from Germany in MIT labs for short-term research stays.

MIT India Program

The MIT India Program sends MIT graduate and undergraduate students to India for industry, research, and teaching internships, enabling these students to gain direct experience of Indian life, science, business, and technology. Established through a pilot project in the summer of 1998, the Program sent 38 students in its first three years to host institutions including GE's John F. Welch Technology Centre (Bangalore), Hikal Ltd. (Mumbai), ICICI Ltd. (Mumbai), Infosys Technology Ltd. (Bangalore), the Kalmadi Shamarao High School (Pune), Tata Steel & the Rotary Club of Jamshedpur (Jamshedpur), and the Telecommunications and Computer Networks Group at IIT Madras (Chennai).

MIT Italy Program

In 1998 MISTI launched the MIT Italy Program, modeled on the MIT Japan Program. It provides internship opportunities for undergraduate and graduate students to combine their knowledge of Italian language and culture with their expertise in the fields of engineering, science, and management. The Program places students in Italian research institutions, companies, and government ministries. In the Fall of 2001, it held its first international symposium in Italy.

MIT Japan Program

The MIT Japan Program established in 1981 is the largest, most comprehensive program of its kind in the country. It routinely places MIT interns in Japanese laboratories after preparing them at MIT with two years of language and with courses on Japanese culture and history. The program currently sends 30–40 interns to Japan each year. Since its inception, the MIT Japan Program has sent more than 700 student interns to Asia. Today, more than half of those students are working with US corporations. The program also conducts workshops, symposia and meetings,

bringing together US and Asian academics, government organizations, and corporations to address critical issues that arise in the areas of international science, technology, and management. Participants form networks to enhance understanding and effectiveness between the Japanese and US science, technology and business communities.

Program sponsors place these bilingual, bicultural professionals in key positions in Japan, America, and East Asia to facilitate communication and to acquire technologies and management expertise. As their companies seek new opportunities in a dynamic Asian environment, many former MIT interns play a strategic role in creating networks that aid in the development of business partnerships and joint ventures.

The Inter-University Committee on International Migration

International migration has become a central feature of globalization in the 21st century. Refugee flows, labor migration, and human trafficking are only a few of the many aspects of migration affecting individual and national security—in both developed and developing countries. CIS chairs the Inter-University Committee on International Migration, an interdisciplinary body founded in 1974, comprising scholars from MIT, Boston University, the Fletcher School of Law and Diplomacy, Harvard and Tufts Universities, and Wellesley College. Its activities include a Migration Seminar Series, specialized conferences and workshops, a working paper series, and a Visiting Fellows Program. Each year, CIS hosts a staff member of the Office of the United Nations High Commissioner for Refugees who participates in the work of the Inter-University Committee on International Migration. In 1998 the Committee initiated the Rosemarie Rogers Working Paper Series with the publication of the study "Missed Opportunities: The Role of the International Community in the Return of the Rwandan Refugees from Eastern Zaire," by Joel Boutroue of UNHCR. A total of 13 working papers have been published in the series, and another 2 are in press.

With a grant from the Mellon Foundation, the Committee runs two year-long seminar series (at MIT and Tufts) and implements the Mellon-MIT Inter-University Program on Non-Governmental Organizations (NGOs) and Forced Migration, which provides competitively awarded small grants for faculty, graduate students, and research scholars at member institutions to conduct research on this topic. Studies by Mellon-MIT grantees are published in this series, or in the Mellon Reports Series. Associate professor Melissa Nobles and Professors Nazli Choucri and Jerome Rothenberg are on the MIT steering committee for this group. Dr. Sharon Stanton Russell is the MIT contact for the committee.

The Inter-University Initiative on Humanitarian Studies and Field Practice

Humanitarian crises of the past decade reflect changing political dynamics. The end of the Cold War and the declining role of superpower regulation of regional and ethnic conflicts have contributed to increasing intra-state conflict and civil war. These crises are characterized by targeted attacks on civilians, mass population dislocation, widespread human rights abuses, and a high level of insecurity for responders—as evidenced in Afghanistan, Angola, Bosnia, Chechnya, Kosovo, Rwanda, Sierra Leone, Somalia, Sudan, and elsewhere. This innovative inter-university program is designed for graduate students seeking an education in the evolving and multidisciplinary field of humanitarian studies. The program allows graduate students at one of the partnering institutions (MIT, Harvard, and Tufts) to pursue a concentration in Humanitarian Studies. Professor Van Evera is the MIT contact for this program.

Demography, Ethnicity, Security

With support from the Smith Richardson Foundation, CIS is completing a project on demography and security. Ten studies were commissioned for a workshop held at the Center in late 1998 on the political consequences of demographic changes and the security implications of state policies to change demographic variables. Two books emanating from the project were published by Berghahn Books in 2002. The first is a volume of essays co-authored by the late Professor Myron Weiner and Dr. Michael Teitelbaum (Alfred P. Sloan Foundation) entitled *Political Demography, Demographic Engineering*. A second, containing the studies commissioned for the workshop, is entitled *Demography and National Security*, edited by Professor Weiner and Dr. Stanton Russell (CIS).

The Project on Race, Ethnicity and Censuses, conducted by Professor Nobles (Political Science), examines the historical development of contemporary political battles over racial census categorization in the United States and Brazil. Both countries have long histories of immigration, both voluntary and involuntary, that are reflected in the categories and uses of census data. A conference at CIS, funded by the Sloan Foundation, brought together scholars in the field. Professor Nobles' completed study, Shades of Citizenship: Race and Censuses in Modern Politics, was published in 2000 by Stanford University Press.

Development Projects, Seminars, and Colloquia

The Joint Faculty Seminar on Political Development (JOSPOD), founded in 1964, is co-sponsored by the MIT Center for International Studies and the Harvard

Weatherhead Center for International Affairs. Suspended in 1999, JOSPOD recommenced in 2001-2002.

The Migration Seminar Series of the Inter-University Committee on International Migration, chaired by Dr. Stanton Russell, explores the factors affecting international population movements and their impact upon sending and receiving countries and relations among them.

The Mellon-MIT Inter-University Program on NGOs and Forced Migration conducts The Mellon Presentations series throughout the year, featuring the work of persons who have received grants from the Mellon-MIT program.

Peoples and States: Ethnic Identity and Conflict, chaired by Professor Jean Jackson (Anthropology), examines the issues of ethnic and nationalist identities in relation to the state.

The Emile Bustani Middle East Seminar, a guest lecture series organized by Dean Khoury (History and CIS), focuses on issues of peace, conflict, and democratization in the Middle East and North Africa.

Women and International Development (WID), a program jointly sponsored by CIS and the Harvard Institute for International Development, conducts seminars and workshops that address issues relating to women and international development.

Political Economy and Technology Policy Program

In this program, the methods and perspectives of political economy are applied to controversial debates in science and technology policy. The program works closely with MIT's School of Engineering in two areas. First, CIS and the Laboratory for Energy and the Environment conduct joint research on the effects of environmental regulation on economic growth, trade, and investment; on how to respond to uncertainty associated with environmental problems; and on tradeoffs between local and global environmental priorities. Second, CIS and the Technology Policy Program are launching a research and training project on emerging technologies. Public policies, business plans, and research funding often rest on expectations of the nature and implications of impending technological changes. This project seeks to improve public and private strategies through explicit analysis of the effects of technological change and associated uncertainty. Professor Kenneth Oye is the program director. Email address: oye@mit.edu.

National Adaptations to a Global Economy

Several projects and series examine national adaptations to an increasingly global economy, with attention to the economic and political implications of increasing integration of goods, technology, and capital markets.

Responses to Security and Environmental Externalities

A second set of projects centers on how security and environmental costs external to markets might best be addressed. Debates over these issues break out into two broad positions. One line stresses potential causes of market failure, then turns to associated public policy responses. A second line stresses potential causes of regulatory failure, then turns to associated proposals for regulatory reform and/or deregulation. The research activities by CIS faculty and affiliates along these two lines are described below.

Asian Energy and Security Working Group

Michael Lynch continued his work with a team drawn from the Security Studies Program, MISTI, and the Japan Program. They are examining security externalities associated with energy and infrastructure choices and evaluating economic and military strategies for addressing these energy externalities. This group has been funded by the CIS innovation fund and by NEDO.

International Aid and Chinese Coal Combustion Projects

Two teams drawn from the Departments of Political Science, Urban Studies and Planning, and Chemical Engineering and the Technology and Policy Program are examining local and international responses to Chinese coal combustion. These CIS joint projects with Tsinghua University, Taiyuan University of Technology, Tokyo University, and the Swiss Federal Institutes of Technology (ETH) have been supported by the Center for Global Partnership, the Alliance for Global Sustainability, NEDO, and ABB.

Uncertainty and Environmental Decisionmaking

CIS research affiliates James Foster and former NRC Policy Division director Lawrence McCray have been leading working groups on regulatory adaptation and on the credible assessment of scientific and technical information. Faculty members assistant professor Brandice Canes-Wrone, Dr. Joanne Kauffman, Professor Oye, Professor Sapolsky, and professor emeritus Eugene Skolnikoff have been participants in conferences and workshops. These activities have been supported by the Consortium on Environmental Initiatives.

Outreach to the Washington Policy Community

The Center for International Studies operates three programs that focus on training and public policy-making. These are addressed to the military and intelligence communities, the State Department and Foreign Service, and to senior congressional staff.

Seminar XXI is an educational program for senior military officers, government officials, and executives in

nongovernmental organizations in the national security policy community. The program provides future leaders of that community with the analytic skills needed to understand other countries and foreign relations generally. Fellows learn to recognize the assumptions that underlie assessments of foreign societies presented to them as policymakers, and to explore policy issues critical to American interests through a variety of lenses. At each session, eminent speakers present alternative perspectives from which to understand a given country or problem. The fundamental criterion for choosing fellows is that they be expected to reach top posts in business, military, or government within the next three to five years. The program, now in its sixteenth year, has about 800 alumni/ae. Professor Robert Art of Brandeis University, a senior associate of the MIT Security Studies Program, directs Seminar XXI. Email address: art@brandeis.edu

Through the Kalker Seminars on American Foreign Policy, American diplomatic trainees of varying rank participate in a series of workshops dealing with critical issues in global affairs. The series brings together distinguished faculty from American and foreign institutions along with high-level State Department and other government officials. Each month diplomatic trainees focus on an in-depth discussion of major issues and American strategies appropriate to a turbulent contemporary global environment. Seminars are held at the State Department's Foreign Service Institute near Washington, DC.

The annual Congressional Senior Staff Seminar provides intensive briefings on a selected issue in science and technology policy for senior members of congressional staff.

Program on Human Rights and Justice

CIS and MIT's Department of Urban Studies and Planning have recently established an interdisciplinary program for teaching, research, and application in human rights. It aims to play a leadership role in advancing the study of—and action on—issues of human rights and justice, especially as they relate to science, technology, and the global economy. Over the past year, the MIT Program on Human Rights and Justice has engaged in diverse activities such as conferences, seminars, and student internships. The Program on Human Rights and Justice is the first in the United States with a specific focus on these issues, and its research activities are designed to increase significantly during the coming years. Professor Balakrishnan Rajagopal is program director. Email address: braj@mit.edu.

Crosscutting Working Groups

In addition to these formal programs, CIS research is conducted via crosscutting projects typically organized as working groups. Because many pressing international issues do not fit neatly within a functionally or regionally defined category, these working groups link CIS programs to one another, to other groups within MIT, and to many outside institutions. Several of these groups are structured to link the efforts of social science professionals with those of engineers and natural scientists on problems of academic and policy significance. Active CIS working groups include:

The Working Group on Nuclear Waste and Proliferation

The Working Group on Asian Innovation and Crises

The Asian Energy and Security Working Group

The Uncertainty and Regulation Working Group

The China Environment Working Group

The Working Group on Civil-Military Relations

Workshops, Lectures, and Seminar Series

The Center for International Studies hosts a variety of workshops, lectures, and seminar series, many of which are open to the Boston area academic community and the public. A list of CIS lectures and seminars follows:

CIS Forum Series (The IAP Forum on the Middle East)

Program on Human Rights and Justice Forums

The Emile Bustani Middle East Seminar

The Security Studies Program (SSP) Seminars

The MIT/Harvard Future of War Seminar

The Star Seminars

General James H. Doolittle Workshop and Dinner

Admiral Levering Smith Seminars

The Seminar on Global Accords for Sustainable Development

The MIT Japan Technology Forum Lecture

Inter-University Seminar on International Migration

Kalker Seminars on American Foreign Policy

Lecture Series on Gender and Politics

Grant Programs

The Center for International Studies administers a variety of fellowships for social science doctoral students at MIT. Three are administered directly by the Center for International Studies:

Mellon-MIT Inter-University Program on NGOs and Forced Migration Research Grants

International Energy and Environment Policy Research Grants

MacArthur Transnational Security Research Grants

In addition to these, CIS serves as the point of contact for three national competitions:

SSRC/International Predissertation Fellowship

Luce Foundation Fellowships (also open to seniors, recent alumni, and junior faculty)

National Security Education Program (NSEP)

During academic year 2001-2002, CIS provided substantial support for approximately 20 graduate students from several departments through these fellowship programs, in addition to the internships provided via MISTI and MIT Japan for undergraduates.

Publications

Several new CIS publications were produced in 2001-2002. *Innovation and Crisis: Asian Innovation after the Millennium*, edited by Dr. Keller and Professor Samuels, was published by Cambridge University Press. *Russian Strategic Nuclear Forces*, edited by Pavel Podvig, was published by MIT Press. Professor Samuels also completed the manuscript for *Machiavelli's Children: Leaders and Their Legacies in Italy and Japan*, forthcoming from Cornell University Press.

In addition to the publications of the Security Studies, Japan, and MISTI programs, the center publishes a bi-annual newsletter, *Precis*, and several working paper series. These include CIS Working Papers, the Rosemarie Rogers Working Paper Series (formerly the Migration Working Paper Series), the MacArthur Transnational Security Working Papers, and the Mellon-MIT Program Working Paper Series.

Professor Thomas J. Christensen published three articles on China's security relations in *China Leadership Monitor* and the chapter on China in *Strategic Asia, 2001–02*, edited by Richard Ellings and Aaron Friedberg.

Professor Karen R. Polenske authored and coauthored a number of studies of energy conservation, energy efficiency, and air-pollution reduction in China. These papers were published as articles in *Journal of Contemporary China and Energy Policy*, and in *Framing the Pacific in the 21st Century: Coexistence and Friction*, edited by Daizaburo Yui and Yasuo Endo. She also contributed chapters on regional economic development strategy to *Entrepreneurship, Firm Growth, and Regional Development in the New Economic Geography, Essays in Honor of Benjamin H. Stevens*, edited by Michael Lahr and Ronald E. Miller, and *Input-Output Analysis: Frontiers and Extensions, Essays in Honor of Ronald E. Miller*, edited by Erik Dietzenbacher and Michael Lahr.

Professor Posen published articles on defense against terrorism in *International Security* and *The National Interest*. He also a contributed a chapter on "Urban Operations: Tactical Realities and Strategic Ambiguities" to *Soldiers in Cities: Military Operations on Urban Terrain*,edited by Michael C. Desch.

Dr. Sharon Stanton Russell's *Demography and National Security*, coedited with Myron Weiner, was published by Berghahn Books.

Professor Sapolsky's article "The Defense Industry's New Cycle," coauthored with Eugene Gholz, was published in *Regulation*. He also coauthored the article "Weighing the Navy," published in *Defense Analysis*.

Dr. Serenella Sferza contributed a chapter on the French Socialist Party to *The Future of Parties*, edited by R. Gunther, J. Linz, and R. Montero.

Professor Judith Tendler reflected on a research agenda for social policy in *Social Policy in a Development Context*, edited by Thandika Mkandawire.

Professor Van Evera coauthored "Weighing the Navy," published in *Defense Analysis*, and contributed the op-ed column "U.S. Should Only Target bin Laden's Gang" to *Newsday*.

Principal research scientist Cindy Williams published "U.S. Federal Spending Choices after September 11" in Breakthroughs and "Defense Policy for the 21st Century" in *Eagle Rules: Foreign Policy and American Primacy in the 21st Century*, edited by Robert J. Lieber.

Professor Elizabeth A. Wood published "The Trial of Lenin: Legitimating the Revolution through Political Theater, 1920–1923" in *The Russian Review* and "The Trial of the New Woman: Citizens in Training in the New Soviet Republic" in *Gender & History*.

Professor David M. Woodruff contributed a chapter on barter and currency in the Russian economy to *La transition monétaire russe: avatars de la monnaie, crises de la finance (1990–2000)*, edited by S. Brana, M. Mesnard, and Y. Zlotowski.

Personnel

Several new administrative assistants were welcomed in 2001-2002, including Tisha Gomes, Magdalena Rieb, and Dee Siddalls. In addition, CIS's executive director, Dr. William Keller, was promoted to the rank of principal research scientist. CIS draws personnel from the MIT faculty and student body, and our personnel policies reflect MIT's commitment to affirmative action goals.

Richard J. Samuels, Director and Ford International Professor of Political Science
William W. Keller, Executive Director and Principal Research Scientist

More information about the Center for International Studies can be found on the web at http://web.mit.edu/cis/.

Program in Women's Studies

Women's Studies continues to build on its success as an interdisciplinary undergraduate program, providing a framework and community for scholarly inquiry focusing on women, gender, and sexuality. By exploring the places of gender cross-culturally, historically, and artistically, Women's Studies subjects strive to help MIT students better understand various constructions of knowledge and value, and realize the range of personal and intellectual discoveries made possible by using gender as a category of analysis. The program is also an important resource and support for faculty with an advanced knowledge of gender studies within particular disciplines but interested in learning more across disciplinary lines; moreover, it welcomes faculty who have an emerging interest in the field of women's studies.

Program Administration

During 2001-2002, the program was directed by Diana Henderson, associate professor of literature, in the fall and by Elizabeth Wood, associate professor of history, in the spring. During AY2002, the Women's Studies steering committee consisted of assistant professor James D. Cain (Literature), visiting associate professor Odile Cazenave (Foreign Languages and Literatures), associate professor Sally Haslanger (Philosophy), Professor Henderson (chair, fall), associate professor Anne McCants (History), Professor Ruth Perry (Literature), Professor Susan Slyomovics (Anthropology), and Professor Wood (chair, spring). Ex-officio members of the steering committee are associate head librarian and collections manager for women's studies Marlene Manoff (Humanities Library) and Women's Studies program coordinator Michèle Oshima. The curriculum committee consisted of Professor Haslanger, Professor McCants (chair), and senior lecturer Wyn Kelley (Literature). The programming committee consisted of Professor Cain, visiting professor Cazenave, and Professor Wood. The advisory committee consisted of Professor Ellen Harris (Music), Professor Molly Potter (Brain & Cognitive Science), Professor Bishwapriya Sanyal (Urban Studies and Planning), and Professor Robert Silbey (Chemistry), dean of science.

Curriculum

The Program in Women's Studies offers an undergraduate curriculum consisting of core classes and cross-listed subjects from several departments. Students may concentrate, minor, and petition for a major departure in women's studies. The Program in Women's Studies offered twenty-four subjects during AY2002, with approximately 300 students enrolled. The curriculum was enriched by two new subjects taught by faculty in several units: Liberty, taught by visiting professor Annabelle Lever (Political Science), and Gender, Space, and Architecture, taught by assistant professor Heghnar Watenpaugh (Architecture). Women's Studies had two majors this year. Assistant professor Emma Teng (Foreign Languages and Literatures) and Professor Wood advised one student on her Women's Studies thesis research. The other major chose the new option of a two-subject substitution in lieu of a thesis. In addition, Professor Haslanger was the program's representative to the Graduate Consortium in Women's Studies (GCWS), which she co-chaired. This year, the GCWS offered three graduate-level courses and a dissertation workshop, in which three MIT graduate students enrolled.

Programming Highlights

Women's Studies programming reflects a wide spectrum of issues and disciplines, especially since many groups and programs, given the absence of an Institute-wide women's center, seek our cosponsorship of events. In keeping with the interdisciplinary and often holistic focus of our field, Women's Studies was pleased to sponsor or cosponsor the following events this year.

McMillan-Stewart Lectures on Women in the Developing World—"Arabic: The Silenced Father-Tongue," by Leïla Sebbar, and "From the Palace to Prison in Morocco," by Malika Oufkir. Cosponsored with the Graduate Consortium in Women's Studies at the Radcliffe Institute for Advanced Study.

"Women's Health and Human Rights in Afghanistan," by Dr. Lynn Amowitz, Brigham and Women's Hospital and Physicians for Human Rights. The talk recounted her experiences interviewing women in Afghanistan and was hosted by Phoebe Schnitzer, MIT lecturer. Cosponsored with the Kelly-Douglas Fund.

"Song of the Water Saints," a reading by Nelly Rosario (MIT '94) from her first novel. Introduced by Brenda Cotto-Escalera (Theater Arts) and cosponsored with the Program in Writing and Humanistic Studies, Council for the Arts, MITE^{2}S, Department of Civil and Environmental Engineering, Counseling and Support Services, Chocolate City, SHPE, NSBE, and authors@mit.

"Caribbean Women Artists: Expressing/Resisting Globalization"—a panel with artist Marilène Phipps, Brandeis professor Faith Smith, novelist and Harvard lecturer Patricia Powell, novelist and MIT alumna Nelly Rosario, and moderator Odile Cazenave (Foreign Languages and Literatures). Cosponsored with the Kelly-Douglas Fund.

"Third Wave Feminism & Popular Culture: Transforming Activism through Media Production"—a panel with Suheir Hammad, Tammy Rae Carland, Mimi Nguyen, and moderator Anita Chan. Organized by Anita Chan and Cynthia Conti, and cosponsored with Comparative

Media Studies, Theater Arts, Council for the Arts, Campus Committee on Race Relations, and LBGT Issues.

"Native American Women Filmmakers"—a panel with Alanis Obomsawin, Arlene Bowman, and moderator Candis Callison. Curated by Candis Callison, produced by Brandy Evans, and cosponsored with the Committee on Campus Race Relations, Council for the Arts, LBGT Issues, and Comparative Media Studies.

Native American Women Filmmakers Video Festival—three screenings featuring 12 films by Native American women filmmakers. Curated by Candis Callison, produced by Brandy Evans, and cosponsored with the International Film Club, AISES, Committee on Campus Race Relations, Council for the Arts, LBGT Issues, and Comparative Media Studies.

Film colloquia cosponsored by Comparative Media Studies—screening/discussion of *Mickey Mouse Monopoly* with filmmaker Chyeng Sun; Australian filmmaker Karen Hughes; and Native American Canadian filmmaker Alanis Obomsawin.

A Woman's Work Is Never Done—a large-scale, site-specific art installation by long-time collaborators Merry Conway and Noni Pratt. Their projects have a large community element, and this work was sited in a neighborhood in Jamaica Plain. Cosponsored with MIT's Office of the Arts, the Women's Industrial and Educational Union, and The Bostonian Society.

Talks on "Vanishing Security: Changing Cultural Practices Among War-Displaced Southern Sudanese Women in Khartoum," by Dr. Rogaia Abusharaf, Tufts University, and "Identification and Analysis of the Tools Used in Sexual and Gender Based Violence Field Research," by Cari Clark, Harvard University. Cosponsored with the Inter-University Committee on International Migration.

Talks on "Women, Human Rights and Globalization," by Hilary Charlesworth, Australian National University, and "Women Refugees Applying for Asylum: Successes and Emerging Challenges," by Deborah Anker, Harvard Law School. Cosponsored with the MIT Program on Human Rights and Justice.

Linda Tillery and the Cultural Heritage Choir in Performance at MIT. Cosponsored with the President's Office; Office of the Arts; Center for the Study of Diversity in Science, Technology, and Medicine; and Committee on Campus Race Relations.

"Is the Western Man's Harem More Enjoyable than the Moslem One?" by Fatema Mernissi. An Emile Bustani Lecture.

"Journey to a Hate Free Millennium." Cosponsored with LBGT Issues.

"What Is Marriage For?" by EJ Graff. Cosponsored with LBGT Issues and the Graduate Consortium in Women's Studies.

"Dilemmas of Gender, Work and Family in the 21st Century"—a panel with Jody Heymann, Harvard School of Public Health, Theda Skocpol, Harvard University, and moderator Ann Bookman, MIT Workplace Center. Cosponsored with the Political Science Department.

"French Family Policy: Challenging US Models of Work and Family," by Jeanne Fagnani, National Center for Family Allocations, France. Cosponsored with the MIT Workplace Center and MIT France.

"The Politics of Welfare Reform"—a panel with Diane Dujon, former welfare recipient, Anne Paulsen, Massachusetts legislator, and moderator Mindy Fried, MIT lecturer.

"Autonomy and Freedom from Fear," by Susan Brison, Dartmouth College. Cosponsored with the Linguistics and Philosophy Department, the dean of humanities, arts, and social sciences, and the dean for graduate students.

"The Right Wing Attack on Affirmative Action"—a panel with Jean Hardisty and Nikhil Aziz, Political Research Associates, and moderator Mindy Fried.

Breast Cancer Information—a talk/session cosponsored with MIT Hillel, AEPhi, WILG, Undergraduate Association, MIT Medical, and Beth Israel Deaconess Medical Center.

Electrical Work—IAP class on Home Repair for Women.

Research, Publications, and Service

The Women's Studies faculty continued their active contributions to their individual fields. Most of their accomplishments are listed in the reports of their home departments, so special attention is given here to achievements relating to work on gender.

Professor Elizabeth Wood (History) published "The Trial of the New Woman: Citizens-in-Training in the New Soviet Republic," in *Gender & History*. She was nominated for the New Directions Fellowship of the Andrew W. Mellon Foundation and received a National Research Competition award from the National Council for Eurasian and East European Research. She delivered the conference paper "Shaming Boys Who Smoke Cigarettes: Agitation Trials in the Late 1920s" at the American Association for the Advancement of Slavic Studies in November 2001.

Professor Evelyn Fox Keller (STS) delivered a guest lecture in the Gender and Society series at Cambridge University. She is on the editorial boards of *Women's Review of Books* and *Hypatia, A Journal of Feminist Philosophy*, and is co-chair of the University of California Systemwide Council on Women's Studies. She wrote the chapter "Making a

Difference in Science" in *Feminism in Twentieth Century Science, Technology, and Medicine*, edited by Angela N. H. Creager, Elizabeth Lunbeck, and Londa Schiebinger, and gave the keynote address at the annual meeting of the University of Wisconsin System Women and Science Curriculum Reform Institute.

Professor Evelynn Hammonds (STS) co-authored the Reports of the Committees on the Status of Women Faculty at MIT and served on the program committee of the Berkshire Conference of Women's Historians. She was a panelist on "Defining Women's Health" at the Radcliffe Institute for Advanced Study, May 2002; the keynote speaker at the Spelman College Phi Beta Kappa Induction Ceremony, April 2002; the inaugural speaker in Drew University's Women's Studies Visiting Scholar Series, February 2002; and a panelist on "Balancing the Equation: Where Are Women and Girls in Science and Technology?" at Barnard College, February 2002. She is a member of the advisory committee for the "Race, Gender and the Sciences at Historically Black Colleges" Curriculum Development Project at Spelman College, and an associate editor of *Signs: Journal of Women in Culture and Society*. Professor Hammonds organized the National Initiative on Minority Women Scientists and Engineers meeting held at MIT, January 2002.

Professor Susan Slyomovics (Anthropology), an elected fellow of the American Folklore Society, wrote the review "Malika Oufkir, Stolen Lives: Twenty Years in a Desert Prison" in *Boston Review of Books*. She serves on the advisory board of *Women and Performance: A Journal of Feminist Theory* and won an NEH fellowship and a Radcliffe Institute/Bunting Fellowship for 2002-2003.

Professor Ruth Perry (Literature) published "Jane Austen and British Imperialism" in *Monstrous Dreams of Reason*, edited by Mita Choudhury and Laura Rosenthal, and "Engendering Environmental Thinking: A Feminist Analysis of the Present Crisis" in the *Yale Journal of Criticism*, reprinted in *Women, Science and Technology* (Routledge, 2001). She was a panelist on "Graduate Teaching as a Way of Generating New Knowledge" at the Conference on the PhD in Women's Studies, October 2001. She delivered the keynote address "The Importance of Aunts" at the Eighteenth-Century Studies conference in Halifax, Nova Scotia, November 2001, and gave the talk "Enlightened Brothers" at the Conference on Enlightenment Masculinities at the University of London, May 2002. Professor Perry also served on the SHASS Committee on Gender Equity.

Professor Diana Henderson (Literature) served as acting director of the Women's Studies Program in the fall. She also served on the SHASS Committee on Gender Equity. She won the Levitan Prize.

Professor Mary Fuller (Literature) published "Images of English Origins in Newfoundland and Roanoke" in *Decentering the Renaissance: Canada and Europe in Multidisciplinary Perspective*, edited by Germaine Warkentin and Carolyn Podruchny.

Professor James D. Cain (Literature) delivered the conference paper "Unnatural History: Neo-Platonic Gender Categories and the Abuse of Nature in the *Topographia Hibernica* of Gerald of Wales" at the Politics and Aesthetics of Gender in the Middle Ages conference of the Illinois Medieval Association, February 2002. His paper "Sexy Beast: Gerald of Wales, the Wild Cow-boys of Ireland, and the Transmutation of Platonic Nature" was accepted for the Modern Language Association meeting, December 2002.

Professor Sally Haslanger (Philosophy) gave the keynote address "Social Geographies: Gender Identity, Racial Identity, Mixed Identities" at the Nordic Women in Philosophy annual conference, Reykjavik, Iceland. She gave another keynote, entitled "You Mixed? Racial Identity without Racial Biology," at the graduate student conference at Kent State University. Her paper "Gender, Race: (What) Are They? (What) Do We Want Them To Be?", published in *Noûs*, was selected as one of the 10 best articles to appear in 2000 by the *Philosopher's Annual* and was reprinted in volume 23 (2001). Professor Haslanger received the Scots Philosophy Club Centenary Fellowship at St. Andrew's University in Scotland, which entails the delivery of a series of lectures on gender and race this summer. She hosted the Society for Women in Philosophy, Eastern Division conference at MIT in April 2002. She co-organized the Workshop on Gender and Philosophy, consisting of monthly dinner meetings with presentations of work in progress by feminist philosophers in the Boston area (http://web.mit.edu/~philos/wogap/). She is a member of the editorial board for the *APA Newsletter on Feminism and Philosophy* and refereed a special issue on "Feminist Science Studies" for *Hypatia, A Journal of Feminist Philosophy*, for which she is the associate editor. She serves on the editorial boards of the Stanford Encyclopedia of Philosophy (online) and the *Studies in Feminist Philosophy* book series, published by Oxford University Press. Her ACLS fellowship is funding a project entitled "Embodied Meanings: Ontology and the Social Construction of Gender and Race."

Professor Emma Teng (Foreign Languages and Literatures) served on the National Advisory Board for The Women's History Museum.

Professor Thomas DeFrantz (Theater Arts) gave the invited lecture "Postcolonial Dancing Bodies" at the University of Minnesota.

Professors Brenda Cotto-Escalera (Theater Arts) and Heather Richardson (History) and lecturer Margaret Burnham (Political Science) are all leaving the Institute as of June 2002.

Future Plans

Professor Wood will serve as the program director through AY2003. She is interested in working to widen faculty participation in the program across the Institute, and to strengthen the sense of intellectual community within women's studies on campus. We hope more of our subjects can be offered on a regular basis by MIT faculty. The program will continue to pay special attention to the international, comparative study of gender and to the roles of women in science and technology—areas particularly appropriate to Women's Studies at MIT.

Elizabeth A. Wood
Program Director
Associate Professor of History

More information about the Women's Studies Program can be found on the web at http://web.mit.edu/womens-studies/www

Dean, Sloan School of Management

This year, the Sloan School of Management refined its strategic direction and focused more tightly on offering the premier programs for shaping innovative leaders who will create, redefine, and build cutting-edge products, markets, and organizations. This focus was adopted as we prepared for our 50th anniversary, which was celebrated in the fall of 2002. This anniversary brought some reflection during the 2001–2002 academic year and this reflection has come to bear on many of our pursuits.

The attacks of September 11, 2001, also deeply affected our year. One of our Management of Technology alumni, David Berray '00, was lost that day, and many members of our community had family, friends, or colleagues who were directly affected. Many efforts were made for and by the students to reach out in that difficult time. The student senate set up a web-based community outreach board. Teach-ins were organized by Professor Richard Locke to explore the lessons of good management in helping to deal with the aftermath of crisis. The memory and affects of that day remain with us as we enter the new academic year.

Educational Programs

Sloan continues to expand and develop innovative programs both within the School and across the Institute.

In cooperation with the Harvard-MIT Division of Health Sciences and Technology, the Biomedical Enterprise Program was launched in June 2002 to enable students to work on product development and commercialization. In two years program graduates will get degrees in health sciences and technology and in management of technology. This program works closely with the MIT Program on the Pharmaceutical Industry.

The Financial Technology Option program is a new graduate minor developed by Sloan and the Department of Electrical Engineering and Computer Science to provide financial engineering training to graduate students in computer science and computer science training relevant to financial services to Sloan graduate students.

In the undergraduate program's new Faculty Advisor Lunch series, several of Sloan's 25 faculty advisors were brought together with a group of students for lunch at the faculty club—allowing for interesting, wide-ranging discussions from management theory to career advice to social topics. The new Lunch with the Dean Program also helped to increase social interaction between faculty and this group of students.

The Leaders for Manufacturing and the System Design and Management programs set up monthly e-seminars to connect alumni via webcast and keep them up to date on trends and strategies. These sessions were presented by LFM and SDM alumni.

Medical Innovations, a new elective, is charting new ground in connecting students and medical specialists to help define solutions to nagging problems in medicine. This program, a joint effort between Sloan, Courses VI and II, and Massachusetts General Hospital, brings a physician into class every other week to talk about their area of specialty and problems they are having in their work. A student team develops solutions and then presents them during class two to three weeks later.

One of the seven MBA management tracks has changed its name from eBusiness to Digital Business Strategy.

The LFM and SDM programs have set up a Systems Engineering Certificate Program for United Technologies Corporation (UTC) to strengthen the expertise of key employees and their managers, to keep UTC competitive.

The Executive Education office continues to expand its offerings to individual companies; for example, the successful innovative Advanced Investments course delivered to Merrill Lynch traders around the world has now completed its second year.

The PhD program had a tremendous year for admissions with a 40 percent increase in applications from the previous year. Twenty-one very promising students were enrolled.

The SDM alumni held their first conference in October 2001, with over 15 percent of the alumni returning to campus for the meeting. The conference theme was Leadership in a Complex and Changing Business Environment.

The Institute approved the use of two Sloan classes (15.279 Management Communication for Undergraduates and 15.301 Managerial Psychology Laboratory) to replace the current undergraduate writing requirement, beginning with the Class of 2005.

Student Programs

This year's four international trips for MBA students to study the business and cultural issues of a particular region included Russia and Poland; United Kingdom, Germany, and Switzerland; West Africa; and China.

Thirty-five students independently organized a spring break trip to Japan to provide opportunities for students to enrich their academic learning by interacting with Japanese business organizations and environments, both in private and public sectors

On April 17, students conducted the 2002 MIT Sloan eBAs (eBusiness Awards), which recognize companies and individuals that have successfully achieved excellence in technology innovation. Of 784 nominees, there were14 winners in various categories. In conjunction with the eBAs and eBusiness Day@MIT, April 17th was decreed eBusiness Day in Massachusetts by Acting Governor Jane Swift.

The winning team of this year's MIT $50K Entrepreneurship Competition, Ancora Pharmaceuticals, included two Sloanies, Jeremy Bender '02 and Carmichael Roberts '00. Runner–up team GreenFuel also had several Sloan students (Nathaniel Harrison '02, Suparna Kadam '02, and Jason Seay '03). The lead organizer was Sloan student Michael Parduhn '02. We're very pleased at the hard work and success of these students and the large number of other Sloan students involved in participating in the competition and running it. It's been a valuable learning experience and a good chance to make connections across the Institute for those involved.

This year's Tech Trek 2002 included 200 students who traveled out to Silicon Valley to visit a variety of public and private firms, network, and learn more about the region. For the first time, this year's Tech Trek offered students the opportunity to interview with a number of companies.

Alumni Involvement

The number of alumni participating in Sloan-sponsored activities grew significantly again this year. Geographic activities doubled with 38 events planned and 3,000 alumni engaged. Alumni weekend drew 28 percent of those invited and included two new features, a career workshop and a family event. Alumni events that bring current students and alumni together continue to be extremely popular and there was significant increase in the number of programs locally and globally. The down economy created an unfortunate and dramatic jump in the number of alumni seeking the services of Sloan's career support office. The number of students and alumni engaged through the alumni advisor program grew again this year. Additionally, Sloan has added a corporate alumni program, taking Sloan to the workplace. This past year the quality of Sloan alumni data was vastly improved through the shared strategy of the alumni relations and alumni giving staff.

New Faculty and Honors

John S. Reed, SM '65, retired chairman and co-CEO of Citigroup, was in residence at Sloan during the month of February. His lectures and discussions provided students and faculty alike with his perspectives on leadership and management.

Arnie Barnett received the INFORMS Expository Writing Award. This award recognizes an author whose publications in operations research and management science have set an exemplary standard of exposition.

Ed Roberts was honored with the Distinguished Speaker Award of the INFORMS Technology Management Section.

Andrew Lo was appointed to the Economic Advisory Board of the National Association of Securities Dealers (NASD). The board advises the NASD on its initiative to modernize its rules and on ways that the NASD can maximize the benefits of its regulation while minimizing its costs.

Nelson P. Repenning and John D. Sterman recently won the 2001 *California Management Review*'s annual Accenture Award for their article "Nobody Ever Gets Credit for Fixing Problems That Never Happened: Creating and Sustaining Process Improvement."

Thomas Allen has been awarded an honorary doctorate by the Ramon Llull University in Barcelona, Spain.

Andrew Lo was chosen from thousands of candidates to receive a Guggenheim Fellowship. Lo was one of only two economists to be awarded a fellowship this year for their distinguished record of achievement. He will study the mental processes by which financial risk perceptions and preferences are formed.

Georgia Perakis was the recipient of Sloan's Graduate Teaching Award. These awards are given each year to one professor from each school, for excellence in teaching a graduate level course.

Stewart C. Myers and his co-author James A. Read, Jr., have won an award from the Casualty Actuarial Society for their paper "Capital Allocation for Insurance Companies." The American Risk and Insurance Association voted "Capital Allocation" the most valuable 2001 paper for the casualty actuarial profession.

John D. C. Little, generally considered the father of marketing science, received the Honorary Doctor of Science in Economics degree from the London Business School for his contributions to management sciences and marketing.

"Understanding Fire Fighting in New Product Development," a paper by Nelson Repenning, won the Thomas P. Hustad Award for the best paper to appear in *Journal of Product Innovation Management* in 2001.

Pablo Boczkowski won an award for his analysis of how the US newspaper industry has extended its print franchise into consumer-oriented electronic publishing.

Donald Lessard was elected dean of the fellows of the Academy of International Business (AIB). AIB is the leading association of scholars and specialists in the field of international business, and publisher of the leading journal in the field.

John Sterman received the Jay W. Forrester Award for the best contribution to the field of system dynamics published in the preceding five years. It is the second time Sterman has received the award.

Steven Eppinger received the ASME International Design Theory and Methodology Best Paper Award at the ASME Design Engineering Conference for his paper entitled "Product Development Process Modeling Using Advanced Simulation." This was the second time he received the award.

Research Centers

With few major structural changes this year, it was a productive year of research at Sloan's centers and programs. These centers have provided detailed summaries which follow this letter. A couple of highlights:

- Through the Center for Coordination Science's project on "Social and Economic Implications of Information Technology," researchers developed a taxonomy of six basic company business models and then classified over 500 companies according to the taxonomy.
- The Center for Energy and Environmental Policy Research began its first year of the three-year Cambridge-MIT Institute Electricity Project.

International Initiatives

Lingnan (University) College of Zhongshan University in Guangzhou, South China, graduated its first class of 65 students from its new International MBA (IMBA) program on June 29. Dean Schmalensee participated in the ceremony. The MIT-China Management Education Project's goal is to establish a common ground of understanding that would lead to the successful integration of China into the world economy. The project began in 1996 and now includes three universities: Lingnan, Tsinghua University in Beijing, and Fudan University in Shanghai.

MIT Sloan and the International Institute for Management Development in Lausanne, Switzerland, formed an alliance to offer a series of jointly developed, run and marketed non-degree executive programs. The first joint program, a five-day offering to be held in spring 2003, will be "Leadership Dilemmas for Profitable Growth: A Top Executive Forum." At least two other similar offerings are planned.

Organizational Changes

The Resource Development Department underwent a reorganization and now has two main groups: Principal/Major Gifts headed by Margaret Keller and Alumni Giving headed by Lori Correale. Associate director for major gifts Nina Bohn was also hired.

GM LFM professor of management Steven Eppinger was named co-director of the LFM-SDM programs. Steven replaces Stephen Graves, who took the position of chair of the MIT Faculty.

New assistant director Maggie Devine-Sullivan joined the undergraduate program.

Robert Greenly was hired as director of leadership in August 2001. His appointment ends August 2002.

At the *MIT Sloan Management Review*, Christine Leamon was promoted to publisher, Christopher Bergonzi joined the group as editorial director, and Professor Arnoldo C. Hax has moved into the role of faculty advisor and chairman of the board.

New Campus Development

Development of our new campus complex is moving forward. In fall 2001 we selected the site, between Memorial Drive and Main Street, adjacent to Building E52. Since then studies were done on how to best use the site. From those studies it was concluded that it would be best to take down the current Dewey Library building and incorporate the library into the new buildings. The concept design stage began in June 2002. The architects are looking at how the School's different needs can be fitted together within the scope of the building to be designed, including what areas should be adjacent to each other. They are also verifying the size of the different building components and doing mechanical and engineering studies. We look forward to more exciting work that should include design over the next year.

Capital Campaign and Fundraising

In Sloan's capital campaign, over $12 million was raised during this academic year with an additional $17 million generated in pledges. With two more years remaining in the campaign, a total of more than $132 million has been raised to support Sloan activities.

Miscellaneous

Sloan Management Review won the 2002 Emerald (formerly Anbar) Golden Page Awards for General Readability and Managerial Application. The Golden Page Awards are presented annually to those few, outstanding management periodicals that consistently deliver excellent articles throughout a calendar year.

Applications for the MBA program hit an all-time high this year with 4,120 students applying. The new application process features competency-based questions designed to get at how applicants think and have behaved, not just why they would like to apply.

The Career Development Office (CDO) struggled with a very tough economy. To combat the economy and a large decrease in corporate presentations, the CDO attracted 40 new companies to recruit, increased by 25 percent the seminars offered to help students in their searches, and expanded their hours. While there was a drop in job offers at the time of graduation, Sloan students seemed to do well compared to competing business schools.

Industry rankings continue to be favorable. In *Forbes's* ranking on "return on investment," Sloan was rated eighth out of 25 schools. In other ratings, Sloan was fourth in *BusinessWeek* and in *U.S. News & World Report*, and sixth in *Financial Times*. *U.S. News & World Report* once again gave Sloan's undergraduate program the number two slot in their ranking, with number 1 slots in several sub-categories. Our program has been in the top three for three years now. In addition, Sloan was ranked number one this year in four undergraduate specialties: information systems, quantitative analysis, operations management, and e-commerce.

Corporate Relations has started a new program called the Sloan Alliance for Sloan's corporate sponsors. They also began a Distinguished Speaker Series to bring prominent CEOs to campus.

A highlight of Leadership Week 2002 was Warren Buffet, who discussed his thoughts on business and his life.

Sloan Technology Services launched the second version of SloanSpace, the School's online portal. They also put a help desk in place to streamline calls for support.

The Sloan admissions web site received a Bronze Horizon Interactive Award for "innovative achievement in interactive media."

In a special note, the United Nations and UN Secretary-General Kofi Annan, Sloan Fellow '72, were awarded the Nobel Peace Prize for striving to create "a better organized and more peaceful world" in the post–cold war era.

2002 Priorities

Our curriculum redesign and the development of our new campus will be two of our biggest priorities this coming year. The occasion of our 50th anniversary brings a stronger historical perspective to this year's curriculum assessment and challenges us to think critically as we did many years ago in forming the School. We look forward to the final recommendations that will come out of the curriculum committee.

We're moving into an exciting stage in our campus development as we start to see concrete design possibilities. Fundraising for our building construction will be challenging, though, in the current economic and business climate. We have found that our alumni have been able to be extremely generous and we remain hopeful that progress will continue on schedule.

A possible educational program change may come from the Sloan Fellows Program and the Management of Technology Program, which will be exploring integration of their programs this year, to evaluate whether a combined relationship would be beneficial.

Richard Schmalensee
John C Head III Dean, Sloan School of Management
Professor of Management and Economics

More information about the Sloan School of Management and its programs can be found online at http://mitsloan.mit.edu/.

Education

Undergraduate Program in Management Science

Again this year, *U.S. News & World Report* ranked the Sloan undergraduate program second (tied with the University of Michigan) for the best undergraduate business program. The program ranked first in the areas of management information systems, quantitative analysis/methods, and production/operations management.

We remain the second largest undergraduate major at MIT—after Electrical Engineering and Computer Science—with over 330 students. Enrollment continues to increase, although at a more gradual level. We also continue to see large numbers of undergraduates from other MIT degree programs enrolling in our management subjects, and we continue to receive many inquiries from students about a Sloan undergraduate minor.

Sloan awarded 154 SB degrees in Management Science this year, an increase of more than 15 percent over last year. The most popular concentration was Finance (66), followed by Information Technologies (17), Marketing Science (15), and Operations Research (six).

Thirty-five percent of our graduates received simultaneous degrees in other MIT departments, compared with 24 percent last year: nineteen received SB degrees in Electrical Engineering and Computer Science, six received SB degrees in Economics, five in Mathematics, two in Biology, and one each in Mechanical Engineering, Brain and Cognitive Sciences, and Physics. One student received an MEng degree in Electrical Engineering and Computer Science. Three other students received two additional degrees: SB and MEng degrees in Electrical Engineering and Computer Science.

Thirty-five of our seniors graduated with at least one minor. The majority were in economics; the others were in the areas of music, political science, comparative media studies, mathematics, and biomedical engineering.

New Communication Requirement

During the year the Sloan undergraduate program proposed, and the Institute approved, the use of 15.279 Management Communication for Undergraduates and 15.301 Managerial Psychology Laboratory to fulfill the new MIT undergraduate Communication Requirement, which will replace the current writing requirement beginning with the Class of 2005. Although these two subjects are already part of Sloan's required undergraduate curriculum, an additional communication project is being developed for 15.301.

Cambridge-MIT Institute

Several MIT departments have established undergraduate student exchanges with their corresponding departments at Cambridge University as part of the Cambridge-MIT Institute (CMI). Although Sloan has not established a direct exchange program, we hosted several CMI undergraduates from other departments in Sloan classes. In the fall of 2001, three CMI students took 15.390 New Enterprises, and in the spring three students took 15.301, three took 15.401 Finance Theory I, and one took 15.665 Power and Negotiation.

Sloan Undergraduate Advising and Committee Assignments

Faculty serving as undergraduate advisors were Professors Thomas Allen, Lotte Bailyn, Dimitris J. Bertsimas, Gabriel Bitran, Paul Carlile, John Carroll, John de Figueiredo, Shane Frederick, Stephen Graves, Leigh Hafrey, Neal Hartman, Starling Hunter III, Jin Gyo Kim, S. P. Kothari, John Little, Stuart Madnick, Fiona Murray, Stewart Myers, James Orlin, Jun Pan, Nelson Repenning, Anjali Sastri, John Van Maanen, Dimitris Vayanos, Yashan Wang, and Roy Welsch. Also serving as advisors were Dr. Jeffrey Meldman, director of undergraduate programs, Maggie Devine-Sullivan, assistant director of undergraduate programs, and Stephanie Karkut, program coordinator.

In an attempt to increase social interaction between advisors and their advisees, the program office hosted a series of advisor/advisee lunches at the MIT Faculty Club. In addition we had a Lunch with the Dean this past spring, also at the Faculty Club. Both events were quite successful and we plan to hold similar events next year. Another project undertaken by our office this year was the production of a new departmental brochure. The brochure—which includes color photos and an insert of the department's current curriculum requirements—is a marked improvement over our previous brochure.

The Undergraduate and Interdepartmental Policy Committee was chaired by Professor John Little and included Professors Allen, Carroll, Eppinger, Graves, Madnick, Vayanos together with Dr. Meldman, Ms. Debbie Berechman, and Ms. Devine-Sullivan. Dean Bitran and Professor Wanda Orlikowski served as ex-officio members. Dr. Meldman served as chair of the Undergraduate Advisors Committee.

MBA Program

The MBA Program at the MIT Sloan School of Management includes three offices: Admissions, Student Affairs, and the Career Development Office. The MBA Program has had a busy and productive year. We hired new people, revamped and enhanced many of our offerings, and created new programs. We've also made strides in terms of student satisfaction and have been recognized with outside rankings (fourth in *BusinessWeek*, fourth in *U.S. News & World Report*, sixth in *Financial Times*). The program's continued high rankings are recognition of our student selectivity, high graduation rate, employment success, and academic reputation.

In keeping with the MIT Sloan School mission statement, we are dedicated to developing effective, innovative, and principled leaders who advance the global economy. We will work toward aligning our offerings with what students need to be successful in their time at Sloan and in their lives after Sloan. We also will refine our marketing message content and delivery, as well as create new offerings and ways of working together to create a more differentiated, successful program.

MBA Admissions

Academic year 2001–2002 was a high-water mark for the MBA Program. This is the first time in our 50-year history that we surpassed the 4,000-application mark. A total of 4,120 applications were received for the MIT Sloan MBA and LFM Classes of 2004. This is also the first time that we have interviewed more than 1,000 candidates. These unprecedented increases in applications (40 percent) and interviews (26 percent) occurred while we transitioned to a new competency-based evaluation and behavioral-event interviewing and worked under the same timeline.

This increase is in line with similar increases experienced by some of our peer schools. The percentage of international applications continued to rise while the percentage of female applicants has remained at 19 percent and underrepresented US minorities (African Americans, Hispanic Americans, and Native Americans) fell to two percent. The mean GMAT score of our applicants is 692.

Several initiatives were launched during AY2002 to increase awareness of the Sloan MBA brand and to expand our pool of qualified candidates. Among them were:

- Expanded Sloan-on-the-Road receptions to 28 US and foreign cities. Local alumni/ae were targeted to attend, an effort that is being expanded this year in conjunction with the Sloan Alumni Relations Office and the Office of External Relations.
- Analyst presentations at Bain (San Francisco, Boston, Milan), A.T. Kearney (firmwide MBA forum; Mexico City; New York), Accenture (New York), Merrill Lynch (New York), Lehman Brothers (New York), PRTM (firmwide), and Belgian American Educational Foundation/McKinsey (Brussels).
- Redesigned the admissions web site, which received a Bronze Horizon Interactive Award for "innovative achievement in interactive media."
- Expanded outreach efforts to underrepresented groups through attendance at industry meetings of the Society of Hispanic Engineers, National Society of Hispanic MBAs, and National Black MBA Association.
- Conducted information sessions for early -stage professionals and undergraduate scholars from UCLA and MIT/Cambridge exchange students.
- Joined forces with the leading 10 schools to recruit early-career professionals (two years' experience and under) in Northern California and New York City, women professionals in Southern California, and underrepresented minorities in the Atlanta area.

MBA Student Affairs Office

The MBA Student Affairs Office staff had an eventful and productive year. Overall full-time MBA student enrollment at Sloan, including Leaders for Manufacturing, is 780 (686 MBAs and 94 LFMs). The MBA Core 2001 included an introductory marketing elective, 15.800, and an introductory finance elective, 15.401. The finance and marketing electives were popular options for the first-year MBAs; 94 percent of the overall MBA Class of 2003 (including first-year Leaders for Manufacturing students) chose to take an elective in their core term, with 27 percent of this group enrolling in marketing and 67 percent taking finance.

After students complete their required fall core requirements, they then choose a specific management track or self-managed track. All tracks require the completion of a sequence of extended spring core electives, in addition to track-specific electives. At the request of the Dean's Office, the MBA curriculum is currently undergoing an extensive review by Sloan faculty and student committees; their decisions about curricular changes for the School's flagship two-year MBA program are expected to be implemented on a pilot basis in AY2004. In the meanwhile, the program's academic and extracurricular policies and direction will be coordinated on an ongoing basis by the School's Master's Program Committee.

The MBA Program currently has a roster of seven management track offerings (financial engineering, financial management, strategic management and consulting, information technology and business transformation, manufacturing and operations, digital business strategy, and new product and venture development). Fifty-eight percent of graduating MBA students completed a management track in AY002, with an especially strong enrollment in the new product and venture development and the financial management track. Forty-two percent of the students opted for the self-managed track, which provides them with maximum flexibility of course selection and the ability to customize their program following completion of the fall core.

MBA students, faculty, and staff participated in four School-sponsored international trips last year. The international trips continued to be an important part of the MBA Program student experience; students, the MBA Student Affairs Office, and Sloan faculty worked collaboratively to organize the trips. An academic seminar that examines the relevant management, social, and cultural issues of the countries precedes the trip. The trip destinations were Russia and Poland; United Kingdom, Germany, and Switzerland; West Africa, and China. More than 92 MBA students participated.

MBA Career Development Office

Academic year 2002 was a challenging but successful one for Sloan students in the MBA job marketplace and for the Career Development Office (CDO) staff assisting them with this process. The rapid downturn in the economy created a significantly less positive employment picture for our students, and increased their need for support. In particular, the lack of opportunity in the management consulting sector led many students to re-evaluate their career goals. In response, the CDO offered over 80 seminars on 54 different topics, created daily walk-in advising hours, invited industry representatives to campus to advise students, created a job matching program, and staffed the Resource Center on Saturdays. The number of seminars offered was an increase from 65 seminars on 31 different topics from the previous year.

Seminar subjects ranged from an overview of effective career management to self-assessment, resume development, networking, conducting a proactive job search, managing relationships with employers, interviewing, negotiating, evaluating offers and making final career decisions. Twenty-three new seminar topics were introduced to address special search issues, including finding a great job in a tough economy, MBA charm school, CDO resources tour, discovering hidden job leads, repositioning yourself after on-campus recruiting, exploratory and networking interview scripts for US and non-US students, job search strategies: alternatives for consultants and Wall Street finance, building a successful career (presented by John Reed '68, former chairman of Citigroup), advanced interviewing skills, and making the most of your summer internship.

The MBA Career Development Office coordinated the logistics for 69 corporate presentations (a decrease of 43 percent from AY2001) and 283 (a 17 percent decrease from AY2001) interviewing companies. The CDO attracted 40 new firms to recruit students during the year; these firms participated in traditional recruiting processes as well as a spring semester career fair.

At graduation, 77 percent of the Class of 2002 reported receiving a job offer. This is a decrease of 13 percent from AY2002, but at the high end of the range of offer rates from peer institutions (72 percent to 80 percent offer rates were reported by competitor institutions). The median starting salary for accepted positions decreased to $86,000 from $95,000 in 2001 due to the marked decrease in hiring by strategy consulting firms and the leveling off of starting salaries across other sectors. Nineteen percent of the Class of 2002 accepted a position in the consulting industry; this is a 26 percent decrease from the previous year.

Top hiring companies for the year include McKinsey, Goldman Sachs, Merrill Lynch, Siebel Systems, and Boston Consulting Group.

Doctoral Program

Sloan's doctoral program aims to provide institutions in the United States and abroad with outstanding management faculty and researchers. In 2002, we graduated 16 PhDs who have taken positions at UCLA, University of Pennsylvania, Yale University, Universidad de Catolica de Chile, New York University, Boston University, Case Western Reserve, and the University of Maryland. While we would like to see more Sloan graduates at the top 20 schools, Sloan PhDs chose their positions based on the strengths of the departments within the schools and the opportunities this presents to influence their futures. A smaller number of graduates chose industry positions with small companies rather than consulting firms and investment banks, which is contrary to the trends of the last few years.

AY2002 was the best year ever for admissions, with 724 applications (a 40 percent increase over 2001) from 55 countries (33 percent alone from China) , due in part to the ease of access to our web site and the application form being available via this method. This was accomplished within the same timetable as last year and no increase in staffing levels or loss of quality control. We made 29 offers and got 21 acceptances (72 percent yield) and believe that the faculty groups offering more competitive financial packages combined with active recruiting, was the reason. This supports last years' assumption that maintaining our competitiveness with other top schools relies on competitive financial offers.

Total enrollment now stands at 91 students (65 international and 26 US; 26 women). The number of under-represented minority students has remained level with two active students. Our participation in the KPMG PhD Project of the past four years has yielded disappointing results (no successful admits or accepts) and we are considering other means to increase our diversity. We also continue to explore other means to increase the participation of minority students in PhD studies here. It is not clear if other schools are doing better, but we are hosting a meeting between the heads of seven major PhD Programs (MIT, Harvard, Wharton, Columbia, Chicago, Northwestern, Stanford) in early September 2002 and hope to learn more about how other schools try to recruit minorities and students in general.

Executive Education

Sloan's Office of Executive Education has continued its efforts to provide superior executive programs to those companies strategically driven by innovation, emerging technologies, entrepreneurship, and global reach. Drawing on Sloan's research depth and expertise, executive education seeks to provide frameworks, concepts, and tools to assist executives in solving critical business problems.

A downturned economy and the aftermath of September 11 negatively affected open-enrollment programs this year. Hardest affected was the two-week program on Latin American business, which had to be cancelled. Fortunately, both the Sloan Fellows and Management of Technology programs, flagship programs for executive education at Sloan, successfully recruited full classes for 2002–2003, indicating a continuing strong demand for these mid-career management degrees. Five executive short courses of five days each were successfully presented in May and June. The portfolio of open-enrollment two-day courses, while suffering a downturn in enrollment from October through March, showed gains through the spring and summer.

Responding to market demand for more customized programs, Sloan increased its offerings of executive education programs for individual companies. Topics of particular interest are strategic management of technology, the impact of emerging technologies on current business models, and the challenges of organization transformation. The Office of Executive Education continues to leverage new learning technologies in both its custom and on-campus programs.

Following on last year's initial offering, a second successful program was delivered to Merrill Lynch, a MIT partnership company. Using distance-learning technology, Professor Andrew Lo's advanced investments course was offered to Merrill Lynch traders around the world. Being at the forefront of new learning technologies allows Sloan's Office of Executive Education to meet the needs of its corporate partners for cutting-edge knowledge on a global basis.

Sloan Fellows

The Sloan Fellows program is the senior degree-granting executive education program in the world. Begun in 1931 with the backing of several industrialists, it was designed as an innovative 12-month graduate program covering the fundamentals of management and managerial decision-making. Now in its 70th year, the program has evolved over the years to keep abreast of a changing world and has remained the leading choice among the world's top corporations to prepare today's managers to be tomorrow's leaders. The individuals designated as Sloan Fellows are fully sponsored by their organizations during their year at MIT.

The program continues to make a significant contribution toward achieving the Sloan School's strategic objectives: to develop effective, innovative, and principled leaders who advance the global economy; and to conduct rigorous and innovative research that improves management theory and practice.

In support of the first objective, the program attracts and educates individuals from corporations that are industry leaders from around the world. The class of 2002 came from 17 US and 37 foreign organizations, many of which have long associations with MIT. They represented 22 different nations spanning six continents

and numerous industries, including automotive, energy, telecommunications, and financial services. This profile provided an excellent opportunity for cross-cultural and cross-industry exchange, a hallmark of the Sloan Fellows Program. The class formed a diverse, mutual-learning community from which individuals took away not only the analytical tools necessary to perform, but also the intellectual confidence to help them to make the right decisions in the complex environments they face. Addressing the second objective, through an active alumni network, strong partnerships with sponsoring organizations, and the Sloan Fellows' thesis work, Sloan faculty have enjoyed many opportunities to conduct research in which to improve management theory and practice.

Active participation by Sloan Fellows alumni in program and MIT events continued. The Seminar in Leadership series and the annual Sloan Fellow Field Trips to New York, Washington, and an international trip to France, Switzerland, and Italy all provided opportunities for alumni to take an active role as speakers and hosts.

A major initiative begun during the year was a comprehensive redesign of the Sloan Fellows Program that will explore the integration of the program with the Management of Technology Program at the Sloan School. The primary objective of the redesign, which will continue through 2003 and include discussions with key stakeholders of the program, is to create an innovative and progressive course of study that meets the management development needs of strategically important sponsors and the professional and personal needs of the Sloan Fellows themselves.

More information about the Sloan Fellows Program can be found at http://mitsloan.mit.edu/sf/.

Sloan Visiting Fellows Program

The MIT Sloan Visiting Fellows Program provides the opportunity to pursue full-time, non-degree studies tailored to individual goals and interests. Each fellow follows a program of study, usually for one or two semesters, that is designed in consultation with a faculty adviser to meet individual professional needs and interests.

Sloan Visiting Fellows is a small program. Participants usually have an existing relationship with Sloan through their company, their school or a member of the Sloan faculty. Enrollment per semester averages around twelve. Seventeen participants were enrolled in fall 2001 and nine in spring 2002.

The 2001–2002 academic year included both self-sponsored and company-sponsored participants as well as visiting students from Ghent University/ Vlerick Leuven Ghent Management School and the Norwegian University of Sciences and Technology (NTNU). The participants from NTNU (14 in the fall and eight in the spring) joined the Management of Technology participants in the Seminar in Management of Technology—a required class for both groups. Since the programs use similar selection criteria, the groups were able to form an excellent cohort through this class and benefited greatly from the exchange of cultures and knowledge.

Sponsors of participants included Samsung Electronics, Hydro Aluminium, Diatec.com AS, Norwegian Defense Communication and Data Services Administration, KPMG Stavenger Norway, Elopak, GE Energy, Skretting AS, Telenor Networks, Norske Hydro, AKSO Nobel Permascand AB, Think Nordic, Nera Networks, Det Norske Veritas (DNV), Telenor Telecom Solutions, Norwegian Institute for Air Research, and Winrich Investment and Co., Inc.

Leaders for Manufacturing

The Leaders for Manufacturing (LFM) program is a partnership between MIT and over 25 global manufacturing firms to discover and translate into teaching and practice principles that produce world-class manufacturing and manufacturing leaders. This partnership is motivated by our shared belief that excellence in manufacturing is critical to meeting the economic and social needs of individuals, firms, and society, and that the health of companies operating in global markets is essential to society's well-being.

Now in its 13th year of operation, LFM is a partnership between the School of Engineering, the Sloan School of Management, and leading manufacturers. Launched in 1988 with significant industry funding, the program emphasizes collaboration and knowledge sharing with its partner companies across the entire spectrum of "Big-M" manufacturing enterprise issues. LFM supports students as program fellows with fully paid tuition. The largest component of the educational effort is the Fellows Program, a 24-month dual master's degree (SM in engineering and MBA or SM in management) experience, involving a single integrative research project carried out on-site in partner firms.

Academic Programs

Forty-seven students in the class of 2002 completed the Fellows Program and approximately 80 percent have taken positions in manufacturing firms. Each of the 47 graduates completed an internship at a partner company during the summer and fall of 2001. Internships are focused projects of concern to the partners, accomplished by interns with company support and MIT faculty guidance. Representative projects this past year included the use of modeling and critical operations data to optimize plant performance, applying lean manufacturing techniques for the design of an aircraft assembly line, and supply chain performance through forecasting.

Another 48 students (Class of 2003) completed their first year of on-campus studies and are starting their six-month internships. Fifty-seven new students (Class of 2004) were admitted and have begun an intensive summer session. The Class of 2004 has an average of 5.5 years of work experience, representing the highest average since the program's inception. Don Rosenfield continues to serve as the director of LFM. Codirectors for the program include Paul Lagace, Bill Hanson, and Steve Eppinger.

Research and Knowledge Transfer Program

As part of LFM and SDM's commitment to lifelong learning, an initiative begun last year was continued to encourage LFM and SDM alumni to stay connected with MIT by sharing relevant information. Paul Gallagher, research associate for LFM and SDM, scheduled monthly webcasts presented by MIT faculty and various LFM and SDM alumni. The content of each webcast, also called e-seminars, provides valuable information on the latest trends, cutting-edge developments and innovative strategies, all of which pertain to manufacturing and/or systems design. The presentations are given in real time, via the Internet and telephone, which allowed participants to follow along visually and audibly as well as ask questions.

Presenters have included Dan Whitney, describing a theory for designing mechanical assemblies to meet top-level customer requirements on key dimensions; Steve Eppinger on product development interaction patterns; and Steve Graves on supply chain modeling and optimization.

Due to the positive feedback, the webcasts will continue into the next academic semester.

Outreach

LFM continues its leadership role in the National Coalition of Manufacturing Leadership (NCML), a partnership of 15 universities with joint management and engineering manufacturing programs. In conjunction with the NCML, MIT, University of Michigan, and Penn State University once again sponsored a recruiting forum, the National Manufacturing Recruiting Forum (NMRF), which was hosted this past year by the University of Michigan. More than 300 students and 20 companies participated in last year's event, in which LFM made a significant contribution by providing a robust, web-based interview scheduling system that increased interview-scheduling efficiency. The number of companies dropped from the previous year's record high of 50 because of the economic downturn. The NCML meets twice a year to share curriculum, research, and program best practices.

Placement

LFM students, sponsored and non-sponsored, continue to be highly sought once they have completed the program. Partner companies as well as other organizations take a special interest in LFM students as proven by their commitment to speak to the class on various issues during the Pro Seminar session. About 80 percent of each class accepts positions within the manufacturing industry while the percentage of students accepting positions within partner companies has remained at about 50 percent.

More information about the Leaders for Manufacturing Program can be found on the web at http://lfm.mit.edu/.

Management of Technology Program

The MIT Management of Technology Program (MOT), the first joint program between the Sloan School and the School of Engineering, was established in 1981 to develop leaders who can create the linkages between their organizations' underlying technology and overall strategy. This 12-month intensive program provides executive development for strong technical leaders who are taking on senior leadership positions in their firms, and has also attracted an increasing number of participants who are involved in technology-based entrepreneurial opportunities.

The MOT Class of 2002 included 56 participants from nearly 20 countries. They averaged 11 years of work experience, representing a wide variety of industries and functional expertise. More than half of the class had advanced degrees prior to joining the MOT Program, most in technical disciplines.

This past year, domestic field trips provided the MOT class an opportunity to visit leading high-technology firms on both coasts of the United States. In November, the annual trip to New York included visits to telecommunications, financial services, media, electronic commerce, and technical consulting organizations. In January, the group spent a great week in Silicon Valley, visiting a wide array of large and small technology-based firms, venture capitalists, and intellectual property consultants. While large firms such as Intel, Cisco, Sun Microsystems, Hewlett-Packard, ChevronTexaco, and Oracle provided great insights into how technological innovation is implemented, much was also gleaned from visits to smaller firms, particularly those involved in wireless applications and web services. A visit to the well-known product design firm IDEO was particularly interesting.

In March 2002 the MOT class headed for Asia, visiting Hong Kong, Taiwan, China, and Japan. Drawing on the many MIT relationships with Asian organizations, very productive visits were hosted by such firms as SONY, NTT DoCoMo, NEC, Quanta Computers, Delta Electronics, TSMC, and Pacific Century Cyberworks. Cultural highlights included a trek to the Great Wall of China and tours of the Forbidden City.

In June 2002 the new Biomedical Enterprise Program was launched after more than two years of preparation. This new program, a result of the unique collaboration between the Harvard-MIT Division of Health Sciences and

Technology and the MIT Sloan School of Management, exposes students to an integrated curriculum focused on the complex process of product development and commercialization in the health care industry. The goal of the new dual-degree program is to create a new generation of leaders for tomorrow's leading biomedical enterprises.

The MOT community was saddened to learn of the death of David Berray, MOT '00, in the terrorist attack on the World Trade Center in NYC. David was attending a financial technology conference at Windows on the World along with another MIT alum, Michael Packer, who also perished in the attack. Both David and Michael had been active contributors to the MOT Program over the years, and both will be missed dearly.

More information about the Management of Technology Program can be found on the Web at http://mitsloan.mit.edu/mot/.

System Design and Management

The mission of the System Design and Management (SDM) program is to educate future technical leaders in the architecture, engineering, and design of complex products and systems, preparing them for careers as the technically grounded senior managers of their enterprises. SDM intends to set the standards for delivering career-compatible professional education using advanced information and communication technologies. SDM was one of MIT's early entries into the field of distance education and remains the only degree-granting program at MIT that can be earned primarily from a remote location.

The SDM program is a joint offering of the School of Engineering and the Sloan School of Management, leading to a Master of Science degree in engineering and management. Targeted for professional engineers with three or more years of experience, the program centers on a 13-course curriculum in systems, engineering, and management, including a project-based thesis. It offers three curricular options: a 13-month in-residence format; a 24-month distance education for company-sponsored students, requiring one academic semester in residence at MIT; and a 24-month on-campus program for self-supporting students who can obtain a research assistantship in one of MIT's labs or centers. The program was conceived as an alternative to the MBA for professional engineers, allowing working professionals to pursue a degree without interrupting their careers and relocating themselves and their families.

Denny Mahoney, director of the SDM Fellows Program, completed his third year in that position, providing a much-needed stability to program leadership. Co-directors for the program include Paul Lagace, Bill Hanson, and Steve Eppinger.

Student Statistics

In January 2002, SDM admitted its fifth class, enrolling 27 students—a drop from previous enrollments. A team led by Professor Paul Lagace, Denny Mahoney, and Jon Griffith, director of partner relations for LFM-SDM, have been engaged for the past few months in an admissions effort for the January 2003 cohort. Final statistics won't be available until the application deadline closes, but numbers of applications have increased significantly with this effort. For the first time, SDM put on an informational evening for local MIT alumni and others interested in SDM. This successful event brought in more than 30 prospective students.

System Design and Management Admissions Statistics

	1997	1998	1999	2000	2001	2002
Admitted	35	58	47	50	37	27
On-Campus	8	16	6	14	8	7
Self-Supported	3	1	2	5	2	1
Research Assistant	3	12	2	4	3	1
Distance Education	27	42	41	36	29	18
Company-Sponsored	29	45	43	41	32	25

System Integration Project

This past year, LFM-SDM and United Technologies Corporation (UTC) embarked on a new educational venture. UTC has identified 11 core capabilities that the corporation believes must be strengthened across all the business units for UTC to remain competitive in the next century. For each capability, UTC will partner with a university that can deliver the highest quality education to its workforce in each of these areas. UTC proposed that LFM-SDM serve as its partner for one of these competencies—systems engineering. UTC believes that much of the current SDM curriculum addresses many of the required capabilities needed for the systems engineering they have identified as important across the UTC business units.

The project team has segmented the educational process into three target populations—a group of experts enrolled in the SDM program, a second group of experts enrolled in UTC-MIT's Systems Engineering Certificate Program, and the managers/facilitators of those experts. The pilot year was very successful, with 11 students completing the certificating program and more than 35 managers/supervisors completing the six days of content in the Manager/Supervisor Workshop. Because of the success of the program, the effort has been extended another year. The next cohort of certificate students numbers 18.

Distance Education Delivery

As MIT's premier degree program offered at a distance, SDM has recognized its leadership role at the Institute regarding the practice of distance education and is evaluating its delivery with the goal of increasing the quality of the remote-learning experience while reducing costs.

Specific distance education accomplishments include:

- SDM's continued delivery of the full range of SDM course offerings to all its students.
- The adaptation of other courses for multi-point videoconferencing to as many as 15 simultaneous company sites.
- Jan Klein's funding by NASA and Ford Motor Company on a project to apply her research on virtual teams to improving the SDM distance learning experience. She conducted a survey and will introduce and measure specific change elements into the program.

SDM facilitated the purchase of a new videoconference bridge for MIT, which is now housed at the Academic Media Production Services (AMPS). This purchase has moved a critical component of the distance education program—videobridging of classes—from an outside vendor to inside MIT at a substantial savings to our corporate sponsors. The advantages of the MIT videobridge include:

- Single supplier for educational support (beyond network access)—MIT
- Greater than 50 percent reduction in the video-conferencing-related costs of distance learning
- Flexibility of providing additional distance learning opportunities

SDM will continue to explore effective ways of making course materials available to distance students.

William C. Hanson
Co-Director

More information about the System Design and Management Program can be found on the web at http://sdm.mit.edu/.

System Dynamics Group

The System Dynamics Group was founded by Professor Jay W. Forrester in the early 1960s. The group was created to pursue research in the area of understanding the importance of structure in the behavior of complex systems, particularly corporate structure. Currently, the group is studying three areas.

The National Model Project, a large computer model, strives for a better understanding of how the US economy works, and is used to help analyze the effects of proposed economic policies. The group uses the National Model to capture the interactions of local structures and decision-making policies, building a bridge that joins microstructure with macrobehavior. Corporations and private individuals fund this research, which is directed by Professor Forrester.

The System Dynamics in Education Project was established in 1990 with private funding. Writing the Road Maps series is the main area of activity. Road Maps is a self-study guide for learning system dynamics and is available free at http://sysdyn.mit.edu/. The series of self-study chapters use modeling exercises and selected literature to provide a way of learning about the principles of system dynamics and its many uses. More recently, a distance learning course in system dynamics called The Guided Study Program has been offered using Road Maps as the core text. This is a large UROP effort involving approximately ten students per term. The educational work of the System Dynamics in Education Project is also headed by Professor Forrester.

The Improvement Paradox: Designing Sustainable Quality Improvement Programs is directed by Professor John D. Sterman. With initial funding in the mid-1990s from an NSF grant, the project studies the design of sustainable quality improvement programs. In the past, many firms abandoned TQM programs due to lack of perceived impact on profitability, even after they experienced a significant increase in performance. Through the development of formal models and original case histories, the project seeks to identify the critical interactions between quality programs and a company's other organizational structures. A number of papers on this work are available from http://web.mit.edu/sdg/www. Corporate sponsors have contributed additional support.

Research

Center for Coordination Science

The MIT Center for Coordination Science conducts multidisciplinary research to help understand how information technology can provide new ways of organizing human activity and help people work together better. Primary funding comes from a variety of government sources, including DARPA and NSF. The center also has corporate sponsorship from Fuji Xerox, Intel, British Telecom, and France Telecom.

The past year has brought significant progress on the three major projects in the center continued from previous years. The NSF project on "Social and Economic Implications of Information Technology" developed a taxonomy of six basic business models for all companies in the economy and completed the classification of over 500 companies according to this taxonomy. The Process Handbook research area completed the second phase of a collaborative project focused on supply chain visualization. This project is integrating the process knowledge management

functionality of the Process Handbook with tangible user interfaces (from the MIT Media Lab) and process simulation tools (from the MIT Systems Dynamics Group). A significantly enhanced prototype was demonstrated in the middle of the year, and a final version is expected by the end of next year. The Adaptive Systems and Evolutionary Software research area made significant progress in the area of exception handling and norms for multi-agent systems.

In addition, center researchers completed the preparation of two edited volumes to be published by MIT Press next year. The working titles of the two volumes are *Inventing the Organizations of the 21st Century* and *Toward a Global Repository for Organizing Business Knowledge: The MIT Process Handbook*.

More information about the Center for Coordination Science can be found on the web at http://ccs.mit.edu/.

Center for eBusiness

The Center for eBusiness, created by the MIT Sloan School of Management, has taken as its mission to be the leading academic source of innovation in management theory and practice for eBusiness. The center engages in research, education, and interaction with industry on all aspects of digital business.

In its third year of existence, the center has been fortunate to maintain its tremendous enthusiasm and support from industry, faculty, and students. This has enabled the center to make some substantial accomplishments, including:

- Commissioning a total of 56 research projects involving 50 MIT faculty and researchers, supported by more than $3 million in industry sponsor funding in FY2002 alone.
- Supporting the development of a new Digital Business Strategy track in the Sloan MBA Program.
- Offering a popular two-day executive education course on Digital Business Strategy three times per year through the Sloan Executive Education Office.
- Engaging the financial support and active participation of 30 corporate sponsors.
- Producing an active sponsor interaction program which included a large three-day annual conference, five other sponsor events, webcasting a weekly series of research lunchtime seminars, the annual eBusiness Awards, and hosting many individual company visits to MIT.
- Establishing a first-class web site for sponsors, faculty, students, and the public, featuring the educational and research outputs of our faculty and students.
- Creating a web-based working paper series and newsletters, which are freely available to all, over the Internet.

As we enter FY2003, we are heartened by the fact that most of our sponsors report an expanded commitment to eBusiness practices, technology, and strategies in their operations. The center plans to continue the activities listed above. We plan to grow by giving our faculty and students more visibility in the business and academic worlds, and by strengthening collaboration with other parts of MIT, including the Media Lab, the Schools of Engineering and Science, and several other research centers at MIT.

While the center has been affected by the recent economic downturn, our FY2003 plans and financing are well positioned with banked funds from fiscal years 2000–2002. While we have projects planned for these funds, we intend to move forward with them cautiously, as we carefully watch the financial fortunes of our corporate sponsors who provide our funding.

More information about the Center for eBusiness@MIT can be found on the web at http://ebusiness.mit.edu/.

Center for Energy and Environmental Policy Research

The Center for Energy and Environmental Policy Research (CEEPR) has been the locus of research at MIT on energy economics since the mid-1970s and on environmental economics since the late 1980s. This research draws on resources from the Sloan School, the Department of Economics, and the Laboratory for Energy and the Environment, and it receives financial support from corporations and government agencies. In conjunction with MIT's Center for Global Change Science, CEEPR co-sponsors the Joint Program on the Science and Policy of Global Change, which conducts interdisciplinary research to inform global climate policy.

Activities and Publications

Academic year 2002 was marked by a significant increase in research activity on emissions trading, as a result of increased funding from earlier EPA grants and four visitors from Chile, India, Austria, and Finland, who participated in the emissions trading research. This year was also the first under the three-year Cambridge-MIT Institute Electricity Project during which CEEPR enjoyed short visits from Professors David Newbery and Michael Pollitt of Cambridge University to coordinate research activities with CEEPR.

During the academic year, eight working papers and five article reprints reporting CEEPR-sponsored research were published, distributed, and posted on the CEEPR web site. In December 2001 and May 2002, CEEPR convened its usual Energy and Environmental Policy Workshop in Cambridge to present research results to corporate and government sponsors and other interested parties. In addition, the first CMI Workshop was held in July 2002 in Spain with the logistical and financial support of HidroCantabrico. Finally, the director and executive

director of CEEPR were invited to give numerous lectures and seminar presentations of CEEPR's research concerning electric utility restructuring and emissions trading, including to committees of the US Congress.

Grants and Research Program

In AY2002, CEEPR sponsored research on the topics of emissions trading, new electricity markets, and energy futures, forwards, and arbitrage. Contributions totaling $555,000 were received from fifteen corporate sponsors and earlier multi-year awards from the US Environmental Protection Agency and the Cambridge-MIT Institute provided another $345,000 in funding. During AY2003, CEEPR will continue to focus its research on electric utility restructuring and emissions trading, and we will welcome Professor Michael Pollitt as a visitor during the spring semester.

More information about the Center for Energy and Environmental Policy Research can be found on the web at http://web.mit.edu/ceepr/www/.

MIT Entrepreneurship Center

The mission of the MIT Entrepreneurship Center is to train and develop leaders who will make high-tech ventures successful. To that end, we offer educational programs to inspire, educate, and coach new generations of entrepreneurs from all parts of MIT. To support this mission, MIT's entrepreneurship professors, practitioners, and staff teach 20 courses and conduct basic research to enhance our fundamental understanding of the dynamic process of high-tech venture development in the United States and around the world.

The MIT Entrepreneurship Center was launched as an Institute-wide initiative in 1996. At that time, President Vest said, "We must not only be the best. We must also serve as a model for others and ensure that, together, we all make a significant global impact in this vital field." To achieve these objectives set out by our president, we established two goals: to recruit 10 leading professors and practitioners and to raise $60 million in endowment to fund their teaching and research.

Since then, our ranks have grown as we continue to recruit world-class educators. In FY2002 we had 10 professors and 12 practitioners teaching our courses. From 1996 to 2002, student enrollment in entrepreneurship courses steadily grew from 288 to over 1,360 students in each of the last two years. We have added at least one or two new courses every year, frequently featuring co-teaching with two or more departments and schools. Enrollment by engineering students has grown steadily.

During FY2002, Simon Johnson, the Ronald A. Kurtz associate professor of entrepreneurship, was granted tenure for his outstanding record of research and teaching. Professor Johnson is the first of our tenure track professors to be so recognized.

Courses offered in FY2002 included the following: 15.986 Building a Biomedical Business, 15.392 Business Plans That Raise Money, 15.369 Corporate Entrepreneurship, 15.394 Designing and Leading the Entrepreneurial Organization, 15.431 Entrepreneurial Finance, 15.835 Entrepreneurial Marketing, 15.399 Entrepreneurship Lab, 15.395 Entrepreneurship/ Venture Capital Without Borders, 15.389 Global Entrepreneurship Lab, 15.615 Law for the Entrepreneur and Manager, 15.390 New Enterprises, 15.974 Personal Entrepreneurial Strategy and Preliminary Venture Analysis, 15.398 Proseminar in New Product and Venture Development, 15.391 Raising Early Stage Capital, 15.976 Starting and Building a Successful Technology-Based Company, 15.393 Technology and Entrepreneurial Strategy, 15.975 The Nuts and Bolts of Business Plans, 15.971/MAS 967 Developmental Entrepreneurship, and Marketing: An Introduction for Entrepreneurs.

During FY2002, Professors Diane Burton, Fiona Murray, and Antoinette Schoar launched a major research initiative, and early results will be available for next year's annual report.

Student organizations supported by and housed in the MIT Entrepreneurship Center continued to be recognized as world leaders. The MIT $50K Entrepreneurship Competition celebrated its 13th anniversary with over 100 business plan entries and a new summer breakfast series for start-ups. The student-run MIT Sloan Venture Capital Conference attracted 500 attendees from over 20 countries.

We continued to engage our alumni community. In addition to regular Entrepreneurship Society functions, the center hosted major networking galas in Boston, London, UK, Tokyo, Toronto, Istanbul, and Munich. The events drew over 1,000 members of the center's network, including MIT graduates engaged in entrepreneurial activity.

Our partnership with the University of Cambridge and the Scientific Enterprise Centers (SECs) in the UK continued to expand. Our second gala dinner was held in London in June. Over 30 representatives of UK SECs attended our 5th annual Entrepreneurship Development Program in January.

We launched a major program to overhaul our web site, managed by Program Coordinator Christie Yih. The center's programs and activities received significant favorable press coverage in *The Economist*, *The Financial Times*, *Boston Globe*, and other European and Japanese newspapers and magazines.

On the financial side, endowment pledges of support from entrepreneurial alumni since 1996 have provided $24 million in seed capital toward our goal of $60 million. During FY2002, 10 corporate sponsors were selected for their ability to add to our educational programs and assist our students and alumni in starting new technology ventures.

Kenneth P. Morse
Managing Director

Laboratory for Financial Engineering

The focus of the Laboratory for Financial Engineering (LFE) is the quantitative analysis of financial markets using state-of-the-art mathematical, statistical, and computational models. The LFE's goals are to spur advances in financial engineering and computational finance, and to support curriculum development for financial technology in undergraduate, graduate, and executive educational programs.

The LFE has continued to receive major funding support for its activities from Merrill Lynch this year as part of the five-year MIT/Merrill Lynch partnership announced in March 1999. As a result, several new research initiatives have been launched in each of the three program areas of the LFE: capital markets, risk management, and financial technology.

The capital markets program area focuses on the mainstream of financial engineering: the pricing and hedging of financial securities, the determinants of capital-market equilibrium, and the empirical and econometric analysis of financial market data. LFE projects in this area include traditional topics such as risk/reward relations for stocks and bonds, asset-allocation strategies, tax optimization, the dynamics of trading volume, derivatives pricing and hedging models, and the impact of transactions costs on portfolio management and trading. However, LFE projects involving nontraditional topics are also supported (e.g., the foundations of technical analysis, agent-based modeling of financial markets, and social-network-analysis models of global financial crises).

The risk management program area focuses on the entire spectrum of issues surrounding the process of rational decision making under risk. This spectrum can be characterized by the so-called Three Ps of total risk management: probabilities, prices, and preferences. Probabilities refers to the statistical laws that describe the evolution of market opportunities and business conditions through time (e.g., "What is the chance of a 20 percent decline in the S&P 500 next month?"). Prices refers to the economic valuation of these market opportunities and business conditions (e.g., "How much will it cost to insure my portfolio against a 20 percent decline in the S&P 500 next month?"). Preferences refers to the ultimate factors that determine how much risk an individual investor or organization is willing to bear (e.g., "How much insurance should I buy?"). Any complete risk-management protocol must integrate these Three Ps into its analysis, and the LFE research projects in this program area will involve all three aspects—statistical models, pricing models, and cognitive and behavioral models.

The financial technology program area focuses on various methodological aspects of financial engineering: mathematical, statistical, computational, and visual. Because financial engineering is naturally interdisciplinary, the tools of financial engineering span a wide range and the opportunities for "intellectual arbitrage" across fields are tremendous. LFE projects in this area will include new methods for nonlinear time series analysis such as wavelet transforms, nonparametric estimation, and support-vector machines; new methods for optimization such as approximate dynamic programming, genetic algorithms, and simulated annealing; computationally intensive methods for Bayesian inference such as Markov Chain Monte Carlo algorithms and Gibbs sampling techniques; computationally intensive methods for quantifying the statistical biases inherent in large-scale data mining such as bootstrap resampling techniques; and new software/hardware platforms for real-time high-bandwidth financial visualization.

The MIT/Merrill Lynch partnership also includes two important educational components: a distance-learning initiative for Merrill Lynch executives and the Financial Technology Option (FTO), a new graduate minor in financial technology that has been jointly developed by the Sloan School of Management and the Department of Electrical Engineering and Computer Sciences in the School of Engineering. The distance-learning program involves the electronic delivery of Professor Andrew Lo's investments course, 15.433, to a select group of Merrill Lynch executives over a 12-week period, along with live chat sessions and group projects developed by Merrill Lynch teams. The MIT FTO program's intent is to provide training in financial engineering for MIT graduate students from technology fields such as engineering, math, computer science and media studies. The minor will increase financial applications within the School of Engineering's technology courses and boost the number of technology courses available to MBA students in Sloan's Track in Financial Engineering. This is the second year of the FTO and approximately 35 students have signed up for the option.

Research support for the LFE has been generously provided by a number of industry sponsors and donors, including the following: Gifford Fong Associates, Lehman Brothers, Merrill Lynch, National Science Foundation, Putnam Investments, Silicon Graphics, Sun Microsystems, Harris and Harris Group, and Morgan Stanley Dean Witter

Andrew W. Lo
Director

Research summaries for each of the LFE projects and their corresponding preprints and reprints, along with LFE staff and affiliated faculty, are described in more detail at the Laboratory for Financial Engineering's web site at http://lfe.mit.edu/.

Program on the Pharmaceutical Industry

The MIT Program on the Pharmaceutical Industry (POPI) was founded in 1991 as a research and education program for understanding the structure and dynamics of the global pharmaceutical industry, including the firms and their suppliers, customers, and regulators.

Currently, more than 15 MIT faculty and numerous outside collaborators from other universities, industry, and government are participating in the research program. Since POPI's inception, some 30 MIT graduate students have completed doctoral work with support from POPI. More than 20 pharmaceutical, biotechnology, or other healthcare firms have contributed funding and/or data for POPI's research or educational activities. As of June 30, 2002, more than 100 articles and working papers have reported on research conducted by POPI faculty and students.

In 2001–2002, faculty associated with POPI continued research on a number of the managerial and policy issues associated with drug discovery and development, the use of new tools to systematize key aspects of drug discovery, pharmacoeconomics, and many other topics.

Recently, the program has positioned itself to work closely with the Institute's new Computational and Systems Biology Initiative. POPI faculty and students are actively focusing on the manner in which science and technology are driving change in drug discovery, development, manufacturing, and the business of pharmaceuticals. These issues form the basis for the content of the Institute's multidisciplinary academic subject 15.136J Principles and Practice of Drug Development, taught in conjunction with five POPI-affiliated faculty members. Of particular interest will be how technological changes are impacting the availability of new drugs and the delivery of health care.

POPI faculty are also working closely with the new Biomedical Enterprise Master's Degree curriculum, offered jointly by the Sloan School of Management and the Harvard-MIT Division of Health Sciences and Technology.

More information about the Program on the Pharmaceutical Industry (POPI) can be found on the web at http://web.mit.edu/popi/.

Productivity from Information Technology

The Productivity from Information Technology Initiative (PROFIT) explores how information technology can enhance productivity in both the private and public sectors. Its research spans diverse areas from finance to transportation, and from manufacturing to telecommunications. Current research efforts include knowledge acquisition (including the extraction of information from paper-based media as well as semi-structured web sources); knowledge discovery (which includes the use of neural network-based data mining techniques); knowledge management and integration (which includes the mapping and assembling of information across departmental, corporate, and national boundaries to suit new conditions and requirements); and knowledge dissemination.

Under the aegis of a broad multiyear agreement with MITRE, significant research was conducted during the year in a number of areas, including data mining, knowledge discovery, and knowledge abstraction and dissemination from a future corporate-wide knowledge infrastructure (http://scanner-group.mit.edu/).

Merrill Lynch, Banco Santander Central Hispano, Suruga, and Fleet Bank are supporting research on the development of Universal Financial Aggregation (UFA) that utilizes work on web wrapper and context mediation. See the project web site at http://context.mit.edu/~coin/ for more information.

During the year, members of PROFIT Initiative continued to serve as founding members of the SSPARC Consortium organized by the MIT Department of Aeronautics and Astronautics. The work at PROFIT was in the areas of design rationale, collaborative design, data mining, and knowledge repositories to enable quicker, better, and cheaper design, development, and manufacture of spacecrafts. See the project web site at http://leanair4.mit.edu/docushare/default.htm for more information.

Researchers of PROFIT also worked on a project funded by the US Department of Transportation, via the MIT Center for Transportation Studies, that involves the use of neural network-based data mining and knowledge discovery techniques to gain new insights into data of the Federal Aviation Administration.

More information about the Productivity from Information Technology Initiative can be found on the web at http://mitsloan.mit.edu/research/profit/profit.html.

Sloan Management Review

Sloan Management Review (SMR) is a quarterly journal providing senior managers with the best current management theory and practice. Selected submissions of research from academia, consulting, and industry are peer reviewed, and cover a range of management disciplines with particular focus on corporate strategy, leadership, and management of technology and innovation.

In a difficult economic year for magazines, SMR held revenues flat over fiscal year 2001. On a bright note, the permissions revenue stream grew 20 percent, where operating agreements with a number of third party distributors and/or partners became productive. Some of these partners include the Los Angeles Times Syndicate International, the European Case Clearinghouse, and EBSCO.

SMR has also implemented cooperative relationships with other Sloan units, providing service of SMR to Sloan alumni, Sloan executive education attendees, and corporate members of the Industrial Liaison Program.

The journal continues to enjoy a healthy stream of manuscript submissions, of which fewer than 10 percent are selected for publication. Nearly 85 percent of lead

authors published were from academic institutions, with the remaining 15 percent from consulting or industry. Of academic lead authors, including Sloan faculty, 62 percent were from top-ten-rated US and international business schools. Of all authors, 18 percent were from international institutions.

A listing of major authors published in issues during FY2002 includes Deborah Ancona, MIT/Sloan; Christopher Bartlett, HBS; David R. Bell, Wharton; Clayton M. Christensen, HBS; Michael Cusmano, MIT/Sloan; Richard A. D'Aveni, Tuck; Thomas Davenport, Accenture and Babson; Kathleen Eisenhardt, Stanford; Charles H. Fine, MIT/Sloan; Jeffrey Garten, Yale; Sumantra Ghoshal, London Business School; Ranjay Gulati, Kellog (Northwestern); Amar Gupta, MIT/Sloan; Michael Hammer, Hammer and Co.; Rosabeth Moss Kanter, HBS; Stuart Hart, Kenan-Flagler (UNC); Christopher Meyer, Cap Gemini Ernst & Young; Henry Mintzberg, McGill; Francesco Modigliani, MIT/Sloan; Nitin Nohria, HBS; C.K. Prahalad, U. Michigan; James Brian Quinn, Tuck; Edward B. Roberts, MIT/Sloan; Jeanne W. Ross, MIT/Sloan; Mohanbir Sawnhey, Kellog (Northwestern); Richard Schmalensee, MIT/Sloan; and Peter Weill, MIT/Sloan.

A number of SMR articles were cited in the press this year. Citation sources included the BBC News web site, *Computerworld*, *Harvard Management Update*, *The Economist*, *Boston Globe*, *Baseline* magazine and web site, and the *Australian Financial Review*.

FY2002 was a year of management changes for SMR. Christopher Bergonzi joined as editorial director. Publisher Susan Petrie left in February to pursue a consulting opportunity, succeeded by Christine Leamon, SMR's former business director. Arnoldo C. Hax, Alfred P. Sloan professor of management, succeeded Michael Cusumano as SMR's faculty advisor and chairman of the board. Professor Cusumano remains active on the editorial advisory board.

Looking ahead to FY2003, the journal plans to continue to refine and deepen its editorial positioning, a process begun with the winter 2001 relaunch. It also plans to expand electronic accessibility to and distribution of its content, through partnerships with a variety of commercial and nonprofit organizations.

Services

Alumni Relations

The past year in Sloan's Office of Alumni Relations has been one with marked growth, successful implementation of a new approach to alumni programming as a key component of Sloan's overall development and advancement strategy, a significant increase in numbers of alumni who have been engaged, and improvement in the quality of our data.

A program to recognize Sloan's 50th Anniversary has been fully planned and marketed to alumni. The program has evolved into a stunning program based in new research, constructed with activity designed to showcase Sloan, and comprised of a star-studded list of speakers.

The quality of our data has been dramatically improved through careful planning and implementation. The 50th Save the Date card mailed to 15,411 alumni asked for address updates, resulting in thousands of changes. A phonation program for the annual fund included as part of the script an address correction section which resulted in improved data. In addition, the Sloan Peoplefinder system and the Advance Database systems were synchronized.

Our "emailable" population is now at 78 percent of our "mailable" population—up from 51 percent. This is the highest percentage of emailable alumni among our peer institutions.

There has been continued improvement in our efforts to track alumni activity and volunteer activity by introducing and training colleagues from across Sloan on the use of the advanced database.

Improved relations between the Sloan and MIT Alumni offices have resulted in better alumni programming both on and off campus through shared resources and enhanced communication. The director for alumni relations is now a permanently included participant at all MIT Alumni Association board meetings helping to facilitate further improvement in both programming, communication, and enhancements to alumni programming. There has been progress made toward sharing resources to improve event-tracking capabilities, which will further enable us to track Sloan's alumni engagement.

Another highlight is the Alumni Admissions Program, a strategy for engaging alumni in the Sloan MBA admissions effort that we have begun to implement.

On the career front, Ken White was hired as a permanent part-time employee to support the career transitional needs of Sloan's alumni. In addition to the ongoing one-on-one meetings that he had been conducting, we have added "alumnet," a weekly gathering of alumni who are currently in the search process. This activity is beginning to take hold throughout the country. Additionally, we have added considerably to the electronic career services that we provide.

The Regional Program, under Lynne Vellante, saw alumni participation in geographic programs more than doubled in 2002. More programming was planned with the specific goal of creating value-added events (faculty presentations, dean's visits). We also implemented a plan of corporate regional alumni programming, with the first such event held at Fidelity with Lester Thurow as speaker.

Year	Number of events	Number of alumni attendees
2000	11	849
2001	17	1379
2002	38	2931

Sloan's Reunion Program, under the leadership of Leanne Schnitzer, showed, once again, improvement in percentage of alumni attending. We continue to work closely and strategically with the Reunion Giving staff in order to create a reunion program that both encourages and showcases reunion giving. Two new events (a Career Workshop and Family BBQ) were added and both were well received by alumni. This year we began a new effort to engage alumni by inviting all local alumni to attend the non-class specific events (Back to the Classroom, Career Workshop, C-function, and the Family BBQ).

Year	Alumni and Guests	Participation
1997	263	12%
1998	387	16%
1999	419	13%
2000	513	16%
2001*	765	17%
2002	663	28%

*(Special effort to engage MOTs recognizing the program's 20th)

Student Activities

During FY2002 the Sloan Student Alumni Committee, a subgroup of the Sloan Student Senate, worked on several projects. This committee, lead by Dana Cole, MBA '02, consisted of 46 student members. The students were first- and second-year MBAs, LFMs, MOTs, and Sloan Fellows. The function of this group is to work on initiatives that bring current students and the alumni population together. Students also gain an understanding of what the Alumni office does and helps build relationships before they become alumni. Most of the initiatives were suggested by the students and are kept running by each year's group.

Admission Alumni Caller Program

This program was started in FY2001 and with the help of the student committee has showed continual growth. The committee has helped create the materials given to alumni when they call admitted students. These materials prep alumni to answer any questions prospective students may have and encourage them to attend Sloan. The committee also helps to identify and solicit alumni volunteers.

Distinguished Alumni Speaker Series

Once or twice a year a noted Sloan alum is invited back to campus to speak to current MBA students about how Sloan has impacted their professional and personal lives. In April, the speaker was Dan Hesse, SF'89, CEO, Terabeam. More then 100 students attended this lunchtime event. The alumni committee works to identify possible speakers and strategize to get them to campus. The committee is also in charge of marketing these events.

Sloan Club of Boston

One member of this committee is selected to sit on the Sloan Club of Boston's Planning Board. This year's student representative was Matthew Rhoden, MBA '02. Part of Matthew's duties as a board member was to serve as the board's secretary. He would report back to the student alumni committee what the club was doing and the events the student population was invited to attend.

Reorientation

The program was started this year for returning students with the goal that they begin to understand their life-long relationship with MIT. The project was put together with help from the MBA Program Office and the CDO. Alumni were asked to speak to returning students to help prepare them for their job search and the current market and to discuss their ongoing connection with the School. Alumni who participated this year were Tony Parham, MBA '90, Charlie Tillett, MBA '91 and Diana Frazier, MBA '81. All second-year students attended this fall event. Following the presentation was the Alumni C-Function for all students and all local alumni. Over 100 local alumni attended.

Disorientation

The student committee works each year to put together a program for all graduating Sloan students. They work on the speakers and the C-function that follows. The agenda is to disseminate information to the graduating class about what the School has to offer alumni and the importance of contributing back to Sloan in both time and money. The keynote speaker was Kenan Sahin, PhD '69, who addressed this issue beautifully. An alumni panel was put together to address the student's questions about the alumni network, job search, alumni clubs, and their thoughts of life after Sloan. The panel participants were Ken Armstead, MBA '82, Sean Brown, MBA '94, Carlo Cadet, MBA '97, Jack Langworthy, MBA '90, Tony Parham, MBA '90 and Alex Wang, MBA '99. There was also a staff panel to address students' questions on what the School offers them as alumni (clubs, reunion, career services, etc.).

Who's Who after Sloan

This program was born out of the Student Alumni Committee. The students were not aware of who the Sloan alumni were and were amazed when they began to hear through different channels who was on the alumni list. They wanted a way to see and be proud of the family they have joined. The group came up with the idea of a Who's Who at Sloan web page on the Sloan site in 2001. The committee set out to make it happen. In 2002 the committee agreed upon the selection criteria and the students set about to identify the alumni who fit this criteria. The list of alumni has been broken up and each student on the Who's Who committee has sent a letter to five alumni letting them know they have been selected and requesting a photo and a bio for the web. To date 34 alumni have agreed to be on the site.

We have chosen to wait until we have at least 100 alumni on the site before making the site live.

Sloan Phone-a-thon

The Student Alumni Committee took charge of recruiting fellow students to participate in the annual fall Phone-a-thon. Twenty-two students and 27 alumni participated.

Class Gift

The Student Alumni Committee led the efforts to raise the class gift from the graduating students. This year is the first to accept pledges. So far the class of 2002 has raised more than $66,000, and pledges are still coming in. This amount is more than double the amounts raised in the programs eight-year history.

Alumni Advisor Program

Formally the Mentor Program, this program has been around for more than 10 years. It allows first-year MBA students to select an alumnus to begin building their networks with. Many students say they chose to attend Sloan because we offered this program. Alumni from our major areas (MA, NY, CA, and all foreign alumni with email addresses) are asked to volunteer.

Past Statistics for the Alumni Advisor Program

Year	Alumni	Students
1997	234	197
1998	409	227
1999	301	204
2000	221	219
2001	385	295

Alumni Class Leaders

The first class to elect alumni class officers was the class of 2001. This proved extremely helpful with the planning of the class's first reunion. The Student Alumni Committee runs the election process. The Class of 2002 officers are Julia Abramovich, vice president; Nisa Bradley, secretary; and Keith Waxleman, president.

Technology

This continues to be an area of great excitement and frustration. The past year was no exception. While alumni data is vastly improved, the resources to provide electronic products continue to be limited.

That said, much of the promotion for reunion was electronic and done with great success. The vast majority of alumni who sign up for reunion and club events do so online. This year we look enthusiastically for improvement in all of these functions. These areas of technological tracking and information gathering and dissemination will provide Sloan with greater and more accurate data regarding the nature and degree of its alumni activity and interest.

Alumni Giving

The Sloan Annual Fund, Dean's Fund for Innovation, and Reunion Giving programs—which make up our overall alumni giving effort—continue to drive our unrestricted gift revenue growth. We raised close to $2 million in unrestricted funds from all sources in FY2002 with the majority of these gifts coming from alumni through the Sloan Annual Fund and the Dean's Fund for Innovation. We continued to expand our Annual Fund program of direct mail, telemarketing, and personal solicitation. Following the lead of the MIT Alumni/ae Association, we used a professional telemarketing consultant to implement a paid caller program in order to solicit a much greater number of our graduates for an annual gift with outstanding results. Our fall volunteer phonathon program continues to bring in a large portion of our unrestricted dollars and the number of students and alumni who participate as volunteer callers increased this year. We made good use of MIT's paid student caller program (Tech Caller) to make in-roads into our population of nondonors. We also continued our Dean's Fund for Innovation program, which markets unrestricted needs to potential leadership donors ($1,000+).

We conducted reunion class gift campaigns with the Sloan Master's Classes of 1997, 1992, 1987, 1982, 1977, 1972, 1967, and 1962. Each of these classes increased their dollars contributed and donors participating over what each of these classes normally gives to the Sloan School in a given fiscal year. The standout this year was the Sloan Master's Class of 1977. This class increased its overall dollars contributed by 225 percent and increased their overall number of donors by 26 percent. We will continue our strategy of focusing on approximately 10 reunion class gift campaigns per year as a means to systematically increase the annual contributions of our graduates to the Sloan School. However, since we only began truly focusing our efforts on reunion giving with appropriate staff and resources in FY1999, we must go through a full five-year cycle (which will be achieved in FY2004) to truly see the impact of our efforts.

Principal and Major Gifts

This was a very good year for growth in the Principal and Major Gifts Program. The dean had a very busy year with travel to Northern California, Southern California, New York, Florida, Madrid, London, Paris, Lebanon, Mexico, Chicago, and Houston to engage alumni and friends in the School's priorities, and to cultivate and solicit financial support for both restricted and unrestricted priorities. Most notably, we solicited and closed on a $5 million gift to support the new Sloan Facility, and worked with senior officers in support of the solicitation of a $10.2 million gift for research and curriculum development. Additionally, we held cultivation dinners in six cities, engaging MBA alumni with the dean, to cultivate them for support of the new facilities. We continued to work with the Sloan Alumni

Building Committee, which provided valuable feedback on the new facility as MIT was considering siting and fundraising issues. Much of the last quarter of FY2002 was spent preparing for FY2003. We identified the 50 or so prospects who will be solicited in FY2003 for contributions to support the new facility. We developed a strategy and timeline for each prospect and began the solicitation of those ready to be solicited.

While we have focused on the new facility, we have also been working to build the long-term strength of the major gift group at Sloan. We hired a new associate director for major gifts and have partnered with staff in Alumni Giving and the MIT Office of Campaign Giving to create a resource development program that is based on strategic cultivation and solicitation and is reinforced by annual support and reunion giving.

Corporate Relations

The second year of the MIT Sloan School of Management's Office of Corporate Relations (OCR) focused on building a corporate relations program to broaden and strengthen relationships with Sloan's top corporate sponsors. We began by making contact with senior executives in each of Sloan's top 20+ corporate sponsors and providing them with information about options for broadening their engagement with the School.

Some of the initiatives of the past year serve as the foundation for next year's activities including:

- A new corporate relations program, the Sloan Alliance, was launched, and a new brochure was designed, published, and distributed widely to internal corporate sponsors who provided funding for faculty research, executive education, or minority fellowship/scholarship programs. The brochure outlines options available to any company interested in developing a relationship with Sloan.
- A Sloan Distinguished Speakers Series began this year. The speaker series, hosted by the dean of the School, targets prominent CEOs from our top corporate sponsors. Plans for this coming year include Michael Dell (Dell), John Thain (Goldman Sachs), Stanley Fischer (Citigroup), and Jeffrey Immelt (GE).
- Sloan's Office of Corporate Relations continued to work closely with MIT's OCR and Industrial Liaison Program. We will continue to strengthen our ties in serving corporate clients by cross marketing programs and collaborating on major corporate events such as guest speakers and conferences, including the 2nd Annual Innovations in Management Conference.

The OCR provides staff support for the Dean's Advisory Council, which meets twice a year to review the School's strategic direction and new initiatives being considered.

On a related matter, the director of OCR played a role in securing corporate funding to support Sloan's 50th anniversary celebration in October 2002.

In addition to continuing to build on each of the elements of the corporate relations program, next year will place increased emphasis on soliciting gifts from—and presenting naming opportunities to—corporate sponsors to support the new Sloan Building complex.

For more information on the Office of Corporate Relations, see the web site at http://mitsloan.mit.edu/business/.

Resource Development

The MIT Sloan Office of Resource Development has undergone significant change this year, both in structure and in leadership. As a group, the office continues to focus on building both the unrestricted support for MIT Sloan and laying the groundwork for a capital campaign for new facilities. As part of the overall MIT Capital Campaign, MIT Sloan has raised gifts and pledges toward projects, facilities, research fellowships, curriculum development, and unrestricted funds. This year the group raised $12.5 million in cash and $17 million in pledges. Included among these gifts and pledges is a pledge of $10 million to support research and curriculum development and a $5 million gift to support the new facility.

More than $132 million has been raised to support MIT Sloan's priorities and projects in MIT's $1.5 billion Capital Campaign, with two full years remaining in the drive. The Resource Development team has been focused to work directly with the dean and associate dean on key fundraising projects. The group now has two interrelated groups: Principal/Major Gifts, headed by Margaret Keller; and Alumni Giving, led by Lori Correale. During FY2002, the dean increased staffing in this joint Resource Development group by two, with additional plans for FY2003 to meet the growing needs of alumni constituencies and fundraising.

Sloan Educational Services

Sloan Educational Services (SES) manages the School's academic infrastructure, supporting all Sloan programs, faculty, and students in the educational process. The SES team is responsible for preparing the physical landscape (facilities maintenance and space renovations), the academic foundation (*Bulletin* updates, course scheduling, student registration, and student advising), and oversight of information flow (internal communications, liaison with MIT Registrar, grades, evaluations).

Our team monitors all registration-related services provided to over 1,200 Sloan students and manages the web-based course prioritization system used by more than 2,000 MIT students; equitably resolves difficult supply and demand issues in a department with increasingly popular classes and already high enrollments; handles scheduling of the

more than 200 class sections and recitations offered each term; maintains Sloan facilities; and produces both online and paper resource materials for the School (including the PhotoBook, student directory, student biocards, and weekly *News@Sloan* newsletter).

Organizational restructuring over the last few years has focused on improvement of SES processes and systems toward excellence in customer service. With an emphasis on enhanced advising and support to the MBA team and students, we are now also strengthening assistance to executive education students, teaching assistants and faculty. The MBA core courses continue to undergo modification, affecting course scheduling, registration, and advising. Continuous improvement and curricular reform initiatives throughout Sloan will, undoubtedly, impose the same challenges in the coming year. SES staff participated in the Dean's Office student revenue project this past year to integrate data from the Sloan course prioritization system. As in previous years, Sloan Educational Services continues to refine its analysis of bidding data to assist Sloan's deans and faculty on issues of demand regarding course and section offerings and teaching load plans.

Facilities management remained a high priority. Sloan Educational Services staff oversaw the renovation of multiple Sloan spaces and the moves of our faculty and staff. Provision of additional student study space, especially for team-based projects, posed a great challenge this past year. SES staff continues to work collaboratively with the Sloan New Building Committee, participating on teams and providing necessary data as a central source of Sloan operations.

Sloan enrollment remains high and Sloan classes continue to attract record numbers of students across all MIT departments. The School continues to explore ways to forecast and meet demand, including additional sections of classes, videotaped sessions, special seminars, and new joint agreements with other MIT departments. It is the role of SES to assist in balancing precious resources such as classroom space and faculty teaching time across all programs. Finding new ways to track and analyze data is vital in this Sloan-wide effort. SES staff aim to daily provide the highest possible levels of service to all constituents while striving to implement continuous improvement.

Goals for 2002–2003 include ongoing initiatives to revise the class scheduling process; automation of the teaching/course evaluation process; design of an auditing database for student record maintenance; bringing student publications online; building a strong SloanSpace web presence to better support Sloan students, faculty and TAs; evaluation of the course prioritization system; enhanced integration of systems and processes; renovating the Building E52 lobby and enhancing current facilities while we plan for those of the future; and, as already mentioned, constantly improving customer service. As always, we will continue our work with students to explore their changing needs and collaborate on creative methods of meeting them.

More information about Sloan Educational Services can be found under the students tab on the Sloan web site at http://mitsloan.mit.edu/.

Sloan Technology Services

Sloan Technology Services supports the information technology needs of faculty, staff, and students at the Sloan School. During the past year we focused on building core capability in IT by solidifying the base infrastructure, strengthening staff knowledge, improving service delivery, exercising project discipline, and enhancing the SloanSpace platform.

We completed the following major initiatives:

- SloanSpace v2—launched SloanSpace v2, which serves as Sloan's online portal with features for course management and community building.
- Help Desk—instituted a Help Desk to provide a single point of contact for faculty and staff computer support. We also recently upgraded our home-grown tracking software to a commercial system with the aim of improving service ticket management, computer asset tracking, and reporting.
- Business Continuity Plan—completed the first draft of a Business Continuity Plan to ensure smooth recovery in the event of server and network outages.
- Database synchronization—completed a two-way database synchronization of alumni records in the Sloan Oracle database with MIT's Advance Oracle database.
- Storage Area Network—installed a Dell/EMC Storage Area Network to increase reliability and performance of our servers.

During the coming year we will establish metrics to assess performance and service delivery. We will also undertake a number of strategic initiatives based on the following principles:

- *Enhance instruction.* As new technology tools and modes of delivery transform the educational landscape, Sloan is presented with new opportunities to enrich the student learning experience. We will work closely with individual faculty, the MBA curriculum redesign team, and the Educational Technology Task Force to identify opportunities to introduce new technologies and learning applications into the curriculum.
- *Support research.* Sloan provides faculty and doctoral students with access to a modest Unix-based computational server and research datasets. We will

extend the notion of "research computing" to include any technologies that can be employed productively by faculty to advance knowledge. As a first step, we will develop a research profile of each faculty member. This will include specifying their content domain, research methodologies, and any special technology needs. We will then investigate what technologies are available to promote the particular faculty member's research. As part of this effort, we also expect to create strong technology partnerships with the research centers in order to leverage our common resources.

- *Build virtual communities.* SloanSpace provides unprecedented functionality for online communities that span students, faculty, staff, alumni, and researchers. The course management feature of SloanSpace is well established, as is the use of online communities by student organizations and program offices. Our goal this year will be to work closely with research centers and alumni office to foster research and alumni communities in SloanSpace.
- *Integrate the enterprise.* Integrating the enterprise is our paramount technical challenge. The architecture of the academic enterprise will progress with the ongoing development of SloanSpace and .LRN (opensource version). We expect to build an international opensource consortium around the opensource version of SloanSpace called ".LRN". In administrative computing, we will begin building a Sloan Executive Information Portal (Project Sapphire) to assist departments with their reporting and planning needs; to create a Sloan Information Map (Project SIM) by tracing and documenting critical institutional processes, databases and systems; to sponsor a Sloan Information Retreat to discuss inter-departmental information processes; and to lay the groundwork for a thorough review and analysis of our administrative systems capability.
- *Cultivate partnerships.* Execution of Sloan's IT strategy will rely on cultivating strong relationships with key firms, entrepreneurs, and the opensource community. We expect to identify, build, and maintain relationships with approximately 10 firms. Ongoing development of SloanSpace and .LRN will depend upon contributions by the opensource community and other institutions using the software.

Dean, School of Science

The School of Science continues to play a leadership role, both nationally and internationally, in science education and research. Our graduate education programs are ranked among the very top in all the disciplines of the school by a variety of organizations. Maintaining that high standard is the highest priority of the faculty and administration in the school.

The School of Science continues to teach a major part of the undergraduate education at MIT. Biology has grown in the last decade to become one of the largest majors at the Institute. In addition, the Departments of Mathematics, Physics, and Chemistry have some of the largest student contact hours. The overall excellence of teaching is exemplified by the number of MacVicar Fellows in the school. Three new faculty were named MacVicar Fellows last year.

The quality of an academic unit such as the School of Science is determined by the caliber of the faculty involved. One of the highest priorities of the school administration is to support our existing outstanding faculty and to recruit to MIT exceptionally talented young researchers and educators, especially underrepresented minorities and women, to our faculty. A new faculty search policy has been established with standards to guarantee every faculty search is used as a vehicle to try to increase the diversity of our faculty. In 2001–2002, 12 new faculty joined the school as assistant professors, including three women and one underrepresented minority. In addition, one woman was hired as full professor.

Our faculty received many honors and awards during the past year, both external and internal. Of particular note, Wolfgang Ketterle won the Nobel Prize in physics 2001, and was elected foreign associate of the National Academy of Sciences; Ann Graybiel won the National Medal of Science 2002, and the James Rhyne Killian Jr. Faculty Achievement Award from MIT.

Other significant honors include: Leonard Guarente was selected by the Academy of the American Society for Healthy Aging to receive its first annual award for significant contributions in the field of aging research; Daniel Kleppner was selected to give the 2002 Robertson Memorial Lecture; Sam C.C. Ting was chosen as the recipient of an honorary doctorate from the National Tsing Hua University for 2002; and Carl Wunsch was elected a foreign member of the Royal Society.

The many new research initiatives and fundamental discoveries that occurred in the various departments and laboratories of the School of Science are discussed below in the reports of those units.

Total new gifts and pledges to the School of Science increased from $16.5M to $36.8M in FY2002.

Academic Programs

There were 794 undergraduate majors in the School of Science during the past academic year, a 3.5 percent increase from the previous year. The number of minority student majors at the undergraduate level changed as follows:

African Americans	30 to 27 (10 percent decrease)
Hispanics	53 to 63 (19 percent increase)
Native Americans	11 to 14 (27 percent increase)
Asian Americans	207 to 213 (3 percent increase)

Sixty-five minors were awarded in the School of Science in AY2002. The female undergraduate population increased from 409 to 426. One-quarter of the Institute's upperclass undergraduates were enrolled in the School of Science. Graduate enrollments in science increased from 1034 to 1048, representing 18 percent of the graduate population at MIT. The number of minority students at the graduate level changed as follows:

African Americans	12 to 16 (33 percent increase)
Hispanics	14 to 12 (14 percent decrease)
Native Americans	3 to 2 (33 percent decrease)
Asian Americans	61 to 61 (no change)

The number of female graduate students decreased from 323 to 320. The overall percentage of female graduate students remained at 31 percent.

The 262 faculty members in the school this past year represents a 3.5 percent increase from the previous year. The undergraduate student-to-faculty ratio remained at three to one, and the graduate student-to-faculty ratio remained at four to one.

Research Volume

The FY2001 research volume was $127.5M, a $6.7M increase over the FY2000 research volume. This figure does not include the significantly increased research volume by MIT faculty at the Whitehead Institute (>$118M), HHMI faculty (>$12M) as well as the research volume associated with School of Science research carried out in the interdisciplinary laboratories reporting to the vice president for research.

Robert J. Silbey
Dean, School of Science
Class of 1942 Professor of Chemistry

Department of Biology

The Department of Biology has 66 active faculty members; 14 in the Whitehead Institute, 13 in the Center for Cancer Research, five hold joint appointments with the Department of Brain and Cognitive Sciences, two are joint with Chemistry, and one is joint with the Department of Civil and Environmental Engineering. Three faculty members also hold appointments in Biological Engineering.

Including active emeritus faculty, the department includes three Nobel laureates, 21 members of the National Academy of Sciences, and nine investigators of the Howard Hughes Medical Institute. The department has a preeminent national and international reputation in research and teaching, and has been a leading contributor to the development and application of cellular and molecular biology.

Educational Activities

In the past year, 314 undergraduates registered as biology majors. Biology remains the largest undergraduate major in the School of Science. The Bachelor of Science in Biology degree was awarded to 95 students (72 in Course VII and 23 in Course VII-A) from September 2001 through June 2002.

A number of biology majors received awards in 2001–2002. Daniel P. Riordan, a senior in biology and math, received the prestigious Churchill Scholarship, which will allow him to spend next year at Cambridge University pursuing an MPhil degree in biological sciences. Tetsuya Matsuguchi received the Hypercube Scholar award for outstanding achievement in computational chemistry and the Randolf G. Wei UROP Award, given to an undergraduate who has made the most outstanding contribution in undergraduate research at the interface of the life sciences and engineering. Two biology seniors received Peter J. Eloranta Summer Undergraduate Research Fellowships, awarded to students planning a summer research investigation or creative study.

The Boit Manuscript Writing Prize was shared by Jesse Barnes, a senior, whose essay title was "Worth More Than Gold: Ensuring Adequate Amounts of Safe Drinking Water in Honduras" and Wendy Ham, a junior, whose paper title was "Brainy Art, Artsy Brain: Using Art to Investigate the Relationship Between the Artistic and Motor Centers of the Brain's Right Hemisphere." Second place in the essay category went to Jenny Lin, a senior in biology, and honorable mention for the prize in writing science fiction went to Kris Schnee, a senior in biology.

Five biology students received sports awards: Anne M. Latham, a senior, received the Burton R Anderson Award, given to the intercollegiate manager of the year. Straight "T" awards for athletic excellence were won by junior Crystal A. Russell (women's basketball), senior Neal K. Devaraj (men's fencing), junior Audrey S. Wang (pistol), and junior Kelly A. Martens (women's volleyball).

The Biology Department presented the following students with awards at the annual senior dinner: Tetsuya Matsuguchi received the Whitehead Prize, awarded to a student showing outstanding promise for a career in biological research; Cindy M. Ku received the Ned Holt Prize, given to a biology major who demonstrates excellence in scholarship as well as in service to the department and the MIT community; Dobrin Draganov was the recipient of the Salvador E. Lauria Prize, awarded for outstanding scholarship and research of publication quality. Elissa M. Schwartzfarb and Tara Mullaney were the recipients of the John L. Asinari Award in recognition of outstanding undergraduate research in the field of life sciences. Stacy Chen received the first Gene M Brown Award, given to a graduating senior who has both an outstanding academic record and has made important contributions to the Biology teaching program.

The following 13 biology students were elected to Phi Beta Kappa: Yi-Ning Cheng, Vanessa J. Cheung, Dobrin D. Draganov, Jennifer A. Erwin, Payal Kohli, Evonne C. Leeper, Adora A. Lin, Daniel F. Morris, Vinod Rao, Daniel P. Riordan, Jill A. Rosenfeld, Angell C. Shieh, and Luke D. Tomycz.

In AY2002, the department awarded a total of 40 PhD degrees and seven SM degrees. Of this total, 35 PhD and six SM degrees were awarded in biology. Five PhD degrees and one SM degree were awarded in the Joint Program in Biological Oceanography with the Woods Hole Oceanographic Institute. The maximum number of PhD candidates registered in the Biology Department in AY2002 was 219, with another 36 in the joint program. The incoming class for fall 2002 will be 39 students, with six additional students in the joint program.

Research

The research activities of the department cover most areas of modern biology, including biochemistry, genetics, microbiology, cancer biology, cell and developmental biology, immunology, neurobiology, virology, and structural biology. The research achievements over the last year are too numerous to be listed but a few are described below.

Susumu Tonegawa's lab identified a gene involved in the retrieval of long-term memories. Using mice with genetically altered NMDA receptors in the CA3 area of the hippocampus, characteristics of neural activity corresponding to the partially cued reactivation of previously formed memories were identified. Understanding how memory works at the molecular level could provide the basis for development of drugs important for Alzheimer's patients and for prolonging the ability of aging people to recall memories and learned facts.

Alex Rich's lab has uncovered a connection between a defect in the editing of messenger RNA and the deadly brain tumor, glioblastoma multiforme. RNA editing status might become a valuable marker for the categorization and prognosis of gliomas and possibly other human cancers.

Rudy Jaenisch's lab reported the partial restoration of immune function in immune-deficient mice, using a combination of nuclear transplantation, gene therapy and embryonic stem cell differentiation to create custom-tailored cellular therapy that obviated problems with transplantation rejection. This approach may be useful for treating human patients with immune deficiencies.

Angelika Amon's lab has discovered that the Cdc14 phosphatase, a key enzyme that regulates mitosis, is released from an inhibitor during anaphase by a reaction network that includes the polo kinase, separase, and several kineticore-associated proteins. Proper regulation of chromosome segregation during mitosis is essential to avoid chromosome loss or damage that can lead to diseases including cancer.

Personnel

Professors Amon and Rebay were promoted to associate professor without tenure. Professor Bartel was promoted to associate professor with tenure. Professors Baker and Kaiser were promoted to full professor.

Chris Burge, an expert in the bioinformatics of eukaryotic gene structure has joined the Biology Department as an assistant professor. The department is also pleased to welcome Drew Endy as a research fellow in bioinformatics, with a joint appointment in biology and biological engineering.

Susan Lindquist joined the department as a full professor and director of the Whitehead Institute for Biomedical Research.

Amy Keating arrived during the past year to set up her laboratory in the Koch Building. She joined the department as an assistant professor.

Barbara Imperiali (chemistry) and Douglas Lauffenburger (biological engineering) both accepted offers of joint appointments with the Department of Biology.

Honors and Awards

Notable honors for faculty and fellows last year included:

Chris Burge was named a TR100 Young Innovator by Technology Review magazine.

Gerry Fink was honored with the Ellison Medical Foundation Senior Scholar Award, the Genetics Society of America George W. Beadle Award, and the Yeast, Genetics and Molecular Biology—Lifetime Achievement Award.

Bob Horvitz received the Wiley Prize in the biomedical sciences, the Genetics Society of America medal, and the Bristol-Myers Squibb Award for distinguished achievement in neuroscience.

Barbara Imperiali was elected to the American Academy of Arts and Sciences.

Vernon Ingram was elected to the National Academy of Sciences.

Rudy Jaenisch was awarded the first Peter Gruber Foundation Award in genetics.

Gobind Khorana received the Centennial honorary degree from Rockefeller University.

Doug Lauffenberger was elected to the National Academy of Engineering and to the American Academy of Arts and Sciences.

Susan Lindquist gave the National Academy of Sciences's Arthur M. Sackler Lecture.

Troy Littleton was named an Alfred P. Sloan research fellow and received a Surdna Foundation research award.

Bob Sauer received the Amgen Award of the Protein Society.

Phil Sharp was honored with the fourth annual Biotechnology Heritage Award from the Biotechnology Industry Organization and the Chemical Heritage Foundation; the Storer Life Sciences Lectures at the University of California, Davis; election as honorary fellow of the Royal Society of Edinburgh, Scotland; an honorary doctorate from Northern Kentucky University; the Norman Davidson lecture at the California Institute of Technology; and the Walker Prize from the Museum of Science, Boston.

Morgan Sheng was elected president of the Society of Chinese Neuroscientists of America and is serving on the nominations committee and education committee of the Society for Neuroscience.

Tony Sinskey was elected a fellow of the Cambridge-MIT Institute Project.

Graham Walker was named American Cancer Society research professor.

Robert T. Sauer
Department Head Luria Professor of Biology

More information about the Biology Department can be found on the web at http://mit.edu/biology/www/.

Department of Brain and Cognitive Sciences

The human brain is the most complex, sophisticated, and powerful information-processing device known. To study mechanisms of the brain and mind, the Department of Brain and Cognitive Sciences combines the experimental technologies of neuroscience and psychology with the theoretical power of computational methods and cognitive science. The department's research focuses on several themes, with each studied at multiple levels of analysis using cellular, systems, computational, and cognitive approaches. The department's faculty also constitute the majority of investigators in the Picower Center for Learning and Memory and the McGovern Institute for Brain Research.

Research

Brain Mechanisms of Vision and Movement

Peter Schiller's lab has studied the role of cortical inhibitory circuits in target selection with visually guided saccadic eye movements, by applying minute quantities of GABA agonists and antagonists to selected brain areas. They found that inhibitory circuits play a central role in visual analysis in the striate cortex and in controlling visually guided eye-movements in the frontal eye fields. These results suggest that the generation of each saccadic eye movement requires not only that excitatory signals be sent to the brainstem oculomotor centers, but also that inhibitory circuits be inactivated.

Mriganka Sur's lab discovered a new property of neurons in early visual cortex. We move our eyes several times a second as we scan a scene, and we tend to successively view locations that differ in structure and composition from the previously viewed location. Experiments demonstrated that such scanning improves visual discrimination, and also the response selectivity of visual cortex neurons. Such rapid plasticity of cortical responses constitutes a simple form of learning that continually influences vision.

Research in Emilio Bizzi's lab has shown that in the motor areas of the monkey's frontal lobe, there is a population of neurons which is selectively recruited during motor learning. They are also studying patients with impaired mobility caused by a stroke affecting the motor areas of the central nervous system to assess the feasibility of a remotely supervised, computer-enabled physical therapy device, administered over high-speed telecommunications.

Learning and Memory

Ann Graybiel's lab has provided an understanding of how activity states of the forebrain are controlled and modulated during motor activity, procedural learning and cognition. This has major clinical relevance for disorders such as Parkinson's and Huntington's diseases, and for neuro-psychiatric disorders such as Tourette syndrome, obsessive-compulsive disorder, attention deficit disorder, and major depression.

Earl Miller's lab has made key discoveries of the neural basis of the high-level concepts, abstractions and functions that guide intelligent behavior. In trained monkeys, they found neural representations of perceptual categories ("cat" vs. "dog"), abstract rules ("same" vs. "different"), and the numbers 1–5, together with an understanding of the neural dynamics underlying short-term memory.

Anthony Wagner's lab carries out fMRI research examining how human memory is organized and supported by the mind and brain. Advances over the past year include: demonstrating that keeping information in active memory contributes to the formation of durable long-term memories and new word learning; characterization of frontal lobe processes that guide semantic memory retrieval; and delineation of the role of specific subregions within the medial temporal lobes during memory formation.

Mathew Wilson, in collaboration with Susumu Tonegawa, demonstrated for the first time the role of the circuits within hippocampal area CA3 in the retrieval of partially cued memories. They identified an explicit physiological correlate of memory retrieval through a process known as "pattern completion." The lab also advanced understanding of the mechanisms of sequence memory formation and retrieval with the demonstration of sequence memory reactivation during slow-wave sleep.

Joshua Tenenbaum, who joined BCS in January 2002, studies learning and inference in humans and machines. Developments in his lab include: the discovery of an apparently universal scaling law of similarity comparison, determining how features of objects or concepts are weighted by people in judging their similarity; improvements to a powerful approach to nonlinear dimensionality reduction that is becoming widely used for scientific visualization and pattern analysis tasks across a number of disciplines; and a novel framework for understanding how people use intuitive theories to learn about the meanings of words and the causal structure of their environment, drawing rich generalizations from very limited perceptual evidence.

Brain Development and Plasticity

Morgan Sheng's lab uncovered three specific proteins that control the growth of dendritic spines (specialized postsynaptic compartments in brain synapses), and revealed the subunit-specific rules that govern the surface delivery of AMPA receptors (an important postsynaptic neurotransmitter receptor) in neurons.

The focus of Guosong Liu's lab is to identify the principles that guide the formation of functional neural circuits. Recently, his lab discovered that the excitatory/inhibitory synapse ratio in a single dendritic tree is always conserved

and the total amount of excitatory synaptic inputs per dendritic branch is scaled according to the surface area of the tree. This led them to propose a new rule that governs the organization of synaptic inputs on a dendritic tree.

Elly Nedivi's lab has been studying the transcriptional regulation of *cpg15*, a gene they isolated in a forward genetic screen for activity-regulated genes that may play a role in synaptic plasticity. They recently found that *cpg15* expression is mediated by molecules and signaling pathways previously associated with synaptic plasticity during learning and memory, and development. *Cpg15* may be one of a set of CREB effector genes whose activity-dependent regulation confers neurons with the capacity for circuit restructuring.

William Quinn's lab studies the fruit fly, Drosophila, which has two kinds of long-term memory. One requires protein synthesis and is mediated by gene transcriptional events. Another (consolidated memory) does not require protein synthesis and depends on the product of the *radish* gene. The cell-signaling pathway leading from and through the ras gene product has been implicated in several developmental and cell-interactive events, notably in human cancers. An aberrant ras gene, when expressed in fly brain structures called mushroom bodies, blocks immediate learning, but the same aberrant gene, when expressed in a pair of large cells that project to the mushroom bodies, blocks memory while leaving immediate learning intact.

Language

Lera Boroditsky, who joined the faculty in fall 2001, has uncovered several ways in which languages shape the way their speakers think about objects, time, and events.

Work in Ted Gibson's lab has focused on determining what constraints make sentence comprehension easy or difficult. It appears that integration cost is sensitive to the kinds of referential expressions (e.g., a pronoun, a name, a full noun phrase) that intervene between two syntactic dependents, and that storage cost affects ambiguity resolution. Another project has demonstrated that in sentence production, the likelihood of producing an intonational boundary is dependent on: the size of the syntactic constituent that was just finished; and the size of the syntactic constituent that is about to be produced. Applications of this work include computer speech generation.

Steven Pinker is conducting a large study of language development in twins, which aims to assess genetic effects on the timing of language development. He is also engaged in research on the neural bases of lexical memory and grammatical computation using fMRI . His sixth book, *The Blank Slate*, on the denial of human nature in modern intellectual life, will be published in September 2002.

The Test of Grammatical Impairment (TEGI) is a result of Ken Wexler's research on linguistic development. This is the first standardized test to select children with Specific Language Impairment that has a scientific basis, and it is expected that it will be the most viable and accurate way to determine which children have this syndrome.

Special Programs

The Friday Departmental Colloquia followed by tea has become an important department-wide event. The weekly lunch presentations organized and run by the graduate students—Brain Lunch and Cog Lunch—continue to flourish, as do the Brain and Machines seminar series sponsored by CBCL and the Plastic Lunch series organized by PCLM. The special events—the semi-annual Teuber Lectures, the annual Bidwell Lecture, and the BCS Reception at the Society for Neuroscience Annual Meeting—have also grown in popularity. Our semi-annual department newsletter is enhancing in scope, and is serving both as a link within our expanding department and a means of keeping our alumni informed of our activities.

Education

Twelve graduate students entered in fall 2001, while 12 students graduated with the PhD. Nine of the latter have assumed postdoctoral positions; one is a continuing MD student at Harvard Medical School; one is now a MS student in MIT's Health Sciences and Technology Program; and one is working on neural network models for advanced process control in industry. Five students were honored for excellence in undergraduate teaching, one student was awarded for excellence in graduate teaching, and three were commended for continuing dedication to teaching. In addition, one student won the Institute-wide Goodwin Medal, which recognizes teaching "conspicuously effective over and above ordinary excellence."

The department had a total of 123 undergraduates this year, and the 37 graduating seniors have been replaced by 34 freshmen. One graduating senior won a Rhodes scholarship, one of two awarded at the Institute and the only one awarded to an undergraduate. In addition, another graduating senior won the Karl Taylor Compton Prize, the highest award presented by the Institute to students and student organizations in recognition of excellent achievements in citizenship and devotion to the welfare of MIT. In MIT's 2002 graduating class, 11 of 58 Phi Beta Kappas were BCS majors.

The Brain and Cognitive Sciences Society (BCSS) was officially launched in the fall of 2001 as an undergraduate-run organization whose aim is to provide information about graduate school, career opportunities, and classes and requirements, in addition to promoting speakers and conferences that may be of interest to BCS undergraduates. The organization also aims to unite the BCS community at MIT by encouraging more interactions between undergraduates and faculty, as well as among undergraduates themselves.

Faculty Honors and Awards

Emilio Bizzi was named Institute Professor. Lera Boroditsky received the Searle Scholars Award and the Surdna Foundation Research Award. James DiCarlo received the 2002 Pew Scholar Award in the biomedical sciences and became an Alfred P. Sloan research fellow for 2002. Ann Graybiel received the James Rhyne Killian Jr. Faculty Achievement Award from MIT and the National Medal of Science for 2002. Nancy Kanwisher was appointed a MacVicar Faculty Fellow. Earl Miller was named associate director of the Picower Center for Learning and Memory. Steven Pinker was designated a Humanist Laureate by the International Academy of Humanism. Tomaso Poggio was named chairman of the Scientific Advisory Board of IRST (Trento, Italy) in 2002. Morgan Sheng was elected president of the Society of Chinese Neuroscientists of America. Mriganka Sur received a Distinguished Alumnus Award from the Indian Institute of Technology and was named Kanpur Fellow in the Neuroscience Research Program. Matthew Wilson received a 2002 Picower Scholars Award. Richard Wurtman was appointed the Smithies Lecturer at Oxford University in May 2002.

Mriganka Sur
Department Head
Sherman Fairchild Professor of Neuroscience

More information about the Department of Brain and Cognitive Sciences can be found on the web at http://web.mit.edu/bcs/.

Department of Chemistry

In academic year 2002, the Chemistry Department continued its strong programs in research and undergraduate and graduate education. Associated with the department currently are 241 graduate students, 133 postdoctoral researchers, and 96 undergraduate chemistry majors. As of July 1, 2002, the Chemistry Department faculty will comprise 34 full-time faculty members, including 7 assistant professors, 1 associate professor, 22 full professors, 1 Institute Professor, and 3 TBA slots. Alice Ting and Stuart Licht will join the department as assistant professors on July 1, 2002.

Faculty Awards and Honors

Professor Moungi G. Bawendi was awarded the University of Chicago Chemistry Department Young Alumnus Award in August 2001. Professor Sylvia T. Ceyer was elected chairperson of the Chemistry Section of the National Academy of Sciences for the term May 1, 2002 through April 30, 2005. Professor Christopher C. Cummins received the Humboldt Research Award for senior US scientists in April 2001 and the 2001 Dannie-Heineman Award in November 2001. Professor Catherine L. Drennan was named a 2001 Searle Scholar. Professor Timothy F. Jamison received the National Science Foundation Career Award and the Boehringer-Ingelheim New Investigator Award. Professor Stephen J. Lippard was awarded the Theodore W. Richards Medal, Northeast Section of the American Chemical Society, and was elected an honorary member of the Royal Irish Academy. Professor Keith A. Nelson was named the visiting Roentgen lecturer at the University of Wuerzburg in Wuerzburg, Germany, endowed by the Volkswagen Foundation. Professor Peter H. Seeberger received the Robert P. Goldberg Grand Prize (MIT 50K competition) as a team member of Ancora Pharmaceuticals, the Harold E. Edgerton Faculty Achievement Award, the Glaxo-Smith-Kline Research Scholar Award and was named an Alfred P. Sloan Research Scholar. Professor Richard R. Schrock won the 2002 Royal Society of Chemistry Sir Geoffrey Wilkinson Medal. Professor Timothy M. Swager was a principal participant in the competition for the Institute for Soldier Nanotechnologies and will be serving as the associate director. Professor Andre Tokmakoff received a 2002 Alfred P. Sloan Fesearch Fellowship, the 2002 Coblentz Award, and the 2001 National Parkinson Foundation Richard E. Heikkila Research Scholar Award.

Education

In the fall of 2001, 50 students entered the graduate program of the Chemistry Department, and from September 2001 through June 2002 the department awarded 34 PhD degrees. The number of graduate students in our program is expected to continue to increase over the next few years as we rebuild the faculty to its normal level.

In 2001, further changes were introduced in our graduate program aimed at reducing stress and improving communication between students and faculty. In particular, several graduate students were appointed to join Professors Essigmann and Imperiali as Chemistry Department mediators. These graduate students are trained and certified by the State of Massachusetts as mediators and serve as a resource for chemistry graduate students, undergraduate students, and faculty/staff as an aid in conflict discussion and resolution. All interaction with the Chemistry REFS program is confidential and voluntary on the part of those requesting assistance.

In the area of undergraduate education, 31 students graduated in June with BS degrees in chemistry, and 22 students completed the requirements for a minor in chemistry. At the annual chemistry majors dinner in May, the recipients of the 2002 undergraduate chemistry awards were announced.

The Merck Index Award for outstanding scholarship was presented to Alexandra Ianculescu of Simi Valley, California, and Ryan Zeidan of Kentwood, Michigan. Neal Devaraj of Manhatten Beach, California, and Michael Torrice of Chelmsford, Massachusetts, were joint recipients of the Alpha Chi Sigma Award, given in recognition of achievement in research, scholarship and service to the department.

Tet Matsuguchi of Saitama-ken, Japan, received the Hypercube Scholar Award for outstanding achievement in the area of computational chemistry. The American Institute of Chemists Foundation Award, presented in recognition of outstanding achievement, ability, leadership and character, was given to Ahmed Ghazi of Cairo, Egypt. Freshman Woon Teck Yap of Singapore received the CRC Press Freshman Chemistry Achievement Award for outstanding academic achievement in chemistry.

The Frederick D. Greene Teaching Award for outstanding contributions in the area of teaching was presented to Bogdan Fedeles of Buzau, Romania, and Herb Chen of Lexington, Massachusetts. Three seniors received the Chemistry Undergraduate Service Award for significant contributions in the area of service to the department: Neena Kadaba of Capistrano Beach, California; Amy Katz of River Vale, New Jersey; and Amy Tyszkiewicz of Sayreville, New Jersey. The ACS Analytical Chemistry Award, presented for outstanding achievement by a junior in analytical chemistry, was given to Zhi-Heng Loh of Singapore.

Seniors Gitrada Arjara of Bronx, New York; Adam Silverman of Pomona, New York; and Dylan Stiles of Newton, Massachusetts were recipients of the Chemistry Undergraduate Research Award for outstanding research

in the field of chemistry. Han Sen Soo of Singapore was also recognized for being awarded the Strem Prize for excellence in undergraduate research at the annual Undergraduate Research Symposium.

The department also expressed thanks to the undergraduates who worked this year as educators at MIT as teaching assistants and tutors: Jyoti Agarwal, Herb Chen, Bogdan Fedeles, Alina Feldman, Dina Feith, Melanie Pincus, Michael Torrice, Amy Tyszkiewicz, John Paul Shen, Crystal Shih, Gitanjali Singh, and Siobhan Walshas as teaching assistants; and Gitrada Arjara, Julia Chen, Karen Cheng, Irina Gorodetskaya, Monica Ho, Neena Kadaba, Neal Mankad, Jyoti Tibrewala, Lisa Smith, Sonya Tang, and Gitanjali Singh as tutors.

Research Highlights

Professor Moungi G. Bawendi's group showed that nanocrystal DFB lasers could be assembled using soft lithography. These lasers can emit at multiple wavelengths simultaneously. His group also showed, in collaboration with Professor Bulovic (EECS) that monolayers of nanocrystal quantum dots could be made to electroluminesce in a molecular organic layered structure. His group showed that the fluorescence from single nanocrystals could be substantially enhanced by coupling the nanocrystals to a rough metal surface.

Stephen L. Buchwald's work has continued on the development of methods for the formation of aromatic carbon-nitrogen and carbon-oxygen bonds. The latter processes are among the most widely used techniques in the discovery groups of pharmaceutical companies.

Sylvia T. Ceyer's group has demonstrated the decomposition of a vibrationally excited, gas phase molecule (Xe-F) that has been produced as a result of a surface chemical reaction. This observation is the first of its kind and highlights the importance of gas phase processes in understanding the overall chemistry of semiconductor etching reactions.

Current research in the Kit Cummins group has resulted from recent discoveries in the areas of low valent niobium and molybdenum chemistry supported by sterically encumbered amido ligands. Recently, we have successfully synthesized a functional form of a three-coordinate niobium trisamide complex. Research in this area has lead to novel transition metal-containing functional groups including an Nb_2P_2 bridging diphosphide unit and terminal NbP phosphide anion. Using an analogous molybdenum system, we have uncovered a novel method for coupling highly functionalized alkynes to metal-bound enealkylidynes. Efficient formation of the corresponding enediynes has been ensued by alkyne metathesis routes. In addition, new reductive cleavage and coupling reactions of organic substrates by low valent titanium and molybenum complexes are currently under study.

A new strategy was developed in Rick L. Danheiser's laboratory for the synthesis of azulenes, a class of highly colored aromatic compounds with unusual spectroscopic and electronic properties.

Catherine L. Drennan's laboratory has determined the first structure of a carbon monoxide dehydrogenase/acetyl-CoA synthase and has discovered that this enzyme contains of new type of cofactor. In this cofactor, iron, sulfur, nickel, and copper are combined into one unique metallocenter. In addition, their research on ribonucleotide reductases was featured on the cover of *Nature Structural Biology*.

John M. Essigmann's group designed two prospective anticancer drugs. In one case a molecule was constructed that has activity against prostate cancer cells in mouse xenografts. In the other, a molecule was designed that has activity against a mouse model of breast cancer. In both cases a ligand for a steroid receptor was linked to a DNA damaging nitrogen mustard. The compounds inhibited DNA repair specifically in tumor cells.

Gregory C. Fu's group has developed more efficient methods for carbon-carbon bond formation using palladium catalysts. Furthermore, we have discovered a variety of new catalytic asymmetric processes, including the addition of amines to ketenes, the hydrosilylation of ketones, the cyclization of alkynals to form cyclopentenones, and the synthesis of beta-lactams.

Research in Robert W. Field's group continues in three areas of intramolecular dynamics: intramolecular vibrational redistribution (IVR) and unimolecular isomerization, intersystem crossing (ISC), and energy transfer between electronic and nuclear motions. Anharmonic interactions in the S1 state of acetylene permit the experimental realization of a "local bender pluck" by which the acetylene<->vinylidene S0 transition state may be selectively illuminated. In our first venture into time-domain spectroscopy, a one-color, phase coherent pump/probe scheme is being set up to determine the quadrupole moment of a molecular ion-core by measuring the precession period of the Rydberg electron orbital angular momentum.

Robert G. Griffin's group has completed the first de novo structure determination of a molecule with solid state NMR. The structure is of the peptide f-MLF-OH which does not crystallize. The distance (±0.3 Å) and torsion angle (±5°) constraints from the NMR experiments are high precision and therefore the structure is quite high resolution (backbone RMSD = 0.02 Å). This will appear shortly in PNAS.

Robert G. Griffin's group has also performed dynamic nuclear polarization (DNP)/NMR experiments on proteins and achieved signal enhancements of 50. These increases in signal intensity are larger that are observed with FT spectroscopy and with 1H detection (HSQC). Therefore,

they could have a significant impact on future directions in solid state and solution NMR. A report describing this work will appear shortly in JACS. The group has received a grant from the NIH to purchase and operate a 900 MHz NMR spectrometer. The instrument will be part of the MIT/Harvard Center for Magnetic Resonance.

In research targeted at the development of multitasking tools for structural and functional proteomics, Barbara Imperiali's group has recently developed small peptides as lanthanide binding tags (LBTs). Because the LBTs are composed exclusively of encoded amino acids they can be introduced as co-expression tags at the DNA level to create fusion proteins. The LBT sequence imparts on the fusion protein a built-in and site-specific fluorophore that can be used for monitoring protein expression and function. The bound lanthanide also provides excellent x-ray scattering power; therefore co-expression of a target protein with an LBT will accelerate the determination of protein x-ray structures by providing an intrinsic, ordered heavy atom for phase determination.

Timothy F. Jamison's group has developed several novel organic reactions that assemble useful molecules efficiently from simple "building blocks." Under continuing development are catalytic coupling reactions of alkynes with aldehydes, imines, and epoxides and catalytic cycloadditions and epoxide-opening cascades that yield oxygen heterocycles. These methods are also the centerpieces of several current projects directed toward the synthesis of natural products with important biological functions such inhibition of HIV infection and cancer treatment.

Stephen J. Lippard's work in synthetic chemistry yielded a carboxylate-bridged non-heme diiron catalyst for the oxidation of substrates using O_2 as the terminal oxidant. This work was based on our understanding of the mechanism of action of a related diiron center in methane monooxygenase. Application of recently designed and synthesized fluorescent sensors for zinc in neuroscience afforded unprecedented views of cells damaged by zinc release following drug-induce epileptic seizure in rats. These same sensors have identified previously unknown zinc-loaded cells in brain.

Keith A. Nelson's research resulted in unique advances in control and characterization of coherent terahertz-frequency vibrational waves, called polaritons, that move at light-like speeds through crystal lattices. An prototype integrated "polaritonics" platform for THz-frequency spectroscopy and THz-bandwidth signal processing has been developed on the basis of these results.

Spin frustration, the focus of Daniel G. Nocera's group's work, represents an extensively studied phenomenon in contemporary condensed matter physics. Of the various lattices displaying spin frustration, layered antiferromagnets with a kagomé-type arrangement of magnetic ions has received the most attention. The jarosite family of compounds has been especially prominent as an ideal model for studying frustrated magnetism in layered kagomé-type antiferromagnets. In the past 30 years, however, these materials, so attractive to systematic magnetic study, have proven extremely difficult to prepare in pure and single crystalline form, rendering the precise determination of their magnetic properties impossible. The group has developed new synthetic methods that yield a perfect kagomé lattice, allowing them to unambiguously characterize for the first time the magnetism derived from spin frustration in this lattice type. The project has evolved to one that is vigorously collaborative, involving this group and the groups of P. Lee, Y. Lee, and M. Kastner in the Department of Physics.

Joseph P. Sadighi's group has developed new, highly electrophilic complexes of late transition metals, using heavily fluorinated supporting ligands. These complexes react with air to generate highly active oxidizing agents. The group is also exploring the metal-catalyzed incorporation of carbon dioxide into organic molecules.

Richard R. Schrock's group has continued to synthesize and test a large number of new catalysts of the type Mo(CHR)(NR')(chiral diolate) and test them in a variety of asymmetric olefin metathesis reactions. This chemistry is expected to have a significant impact in the synthesis of drugs and pharmaceuticals. The group has also expanded this considerable chemistry to tungsten. They have developed sterically crowded cationic complexes of hafnium that will polymerize ordinary olefins such as 1-hexene in a living manner (at 0°C up to 600 equiv). They are now studying the effects of various anions, solvents, and olefins themselves on the kinetics and mechanistic details of this well-behaved polymerization reaction. The group has discovered how to prepare molybdenum complexes that contain extremely bulky arylated triamidoamine ligands and have found that they are catalysts for the reduction of molecular nitrogen in the presence of protons and a reducing agent. They have now demonstrated that dinitrogen can be reduced catalytically under some conditions, and are working to optimize that catalytic reaction by varying the ligand structure and the nature of the reducing agent and proton source.

In the past year Peter H. Seeberger's laboratory has utilized their automated oligosaccharide synthesizer to rapidly assemble a malaria toxin carbohydrate. In collaboration with a group at WEHI in Australia this highly effective anti-toxin malaria vaccine in mice. In the near future this malaria vaccine will be tested in primates.

Jeffrey I. Steinfeld's work has employed high sensitivity cavity enhanced spectroscopic techniques to detect trace vapors and short-lived reactive species. Cavity RingDown Spectroscopy has been used to detect a variety of trace

vapors in atmospheric mixtures. The IntraCavity Laser Absorption Spectrometer has been modified to measure reaction kinetics of free radicals and other short-lived reactive species.

Timothy M. Swager's research group has discovered a new reversible resistance based method for the detection of nitric oxide, has demonstrated (with Vladimir Bulovic, EECS) that semiconductor polymer laser sensors can provide an additional 100 fold sensitivity over the best previously devised sensors (breaking their own record) and had developed a novel approach to the problem of interlayer dielectrics that are necessary for achieving optimal performance in small (0.13 micron) feature size semiconductor devices.

Andrei Tokmakoff's group has developed new methods for two-dimensional infrared spectroscopy, which can be applied to study transient molecular structure and molecular dynamics in solution. A new femtosecond mid-infrared laser source was constructed, which will be used to study the molecular dynamics of the hydrogen bond network of liquid water. Additionally, new methods for acquiring two-dimensional infrared spectra are now being applied to study the infrared spectroscopy of protein secondary structure.

Stephen J. Lippard
Department Head
Arthur Amos Noyes Professor of Chemistry

More information about the Department of Chemistry can be found online at http://web.mit.edu/chemistry/.

Department of Earth, Atmospheric and Planetary Sciences

The Department of Earth, Atmospheric and Planetary Sciences (EAPS) has broad intellectual horizons that encompass the solid earth, its fluid envelopes, and its diverse neighbors throughout the solar system and beyond. The department seeks to understand the fundamental processes defining the origin, evolution and current state of these systems and to use this understanding to predict future states. The department currently comprises 38 faculty, including two with primary appointments in Civil and Environmental Engineering, 174 graduate and undergraduate students, and more than 100 research staff, postdoctoral appointments, and visiting scholars. EAPS is notable for its collaborations with other MIT departments and schools to address complex interdisciplinary problems. In this vein, the department is an enthusiastic supporter of the new Earth Systems Initiative.

Educational Activities

EAPS has vigorous graduate educational programs in geology and geochemistry, geophysics, atmospheres, oceans, climate, and planetary science. Each discipline of EAPS continues to be ranked among the top graduate programs in the country, with most areas being rated either first or second nationally. The EAPS graduate program currently focuses on the PhD degree, which is the goal of about 90 percent of its graduate students. During the past academic year, 149 graduate students were registered in the department including EAPS students in the MIT/Woods Hole Oceanographic Institution (WHOI) Joint Program. Of these, 107 are US citizens, and 42 are international students. Women constitute 44 percent of the graduate student population. EAPS awarded 21 PhD and 13 SM degrees during AY2002. A bi-annual prize continues to be awarded to recognize and reward the efforts of outstanding EAPS graduate teaching assistants.

EAPS continues to maintain a strong presence within the undergraduate program at MIT. It offers a wide variety of Freshman Advising Seminars each fall with about 10 faculty members participating each of the past three years. A new undergraduate seminar has been developed to introduce newly declared sophomore majors to the broad research interests of the faculty. In the past two years, EAPS gained a total of 21 new majors, which is a significant increase compared to prior two years. The EAPS Independent Activities Program (IAP) continues to be one of the most vibrant at MIT, and faculty have maintained a healthy Undergraduate Research Opportunities Program (UROP) including opportunities for field experience in geological settings, astronomical observations and national laboratories. The new Terrascope program, discussed below, has the potential to further increase the number of EAPS majors.

An exciting new activity for the department is the Earth Systems Initiative (ESI), which began this past spring. This major new undertaking will be aimed at providing an in-depth understanding of the intimate relationships between biological and geological processes that operate over the full extent of time and space scales on Earth. This is an interschool undertaking, with EAPS and the Department of Civil and Environmental Engineering (CEE) being the largest players. The ESI has significant science, engineering and educational facets. Kip Hodges of EAPS and Penny Chisholm of CEE and Biology will be co-directors. More information about ESI can be found online at http://web.mit.edu/esi/.

Associated with the launch of the ESI is a new Earth System Freshman Core Program called Terrascope. This innovative alternative to the freshman core program will use the Earth system as context for the physics, mathematics, chemistry, and biology subjects in the science core. The new program will include a participating design class modeled after 12.000 Solving Complex Problems and will involve EAPS and CEE faculty in teaching and advising roles. Terrascope will be led by the new ESI co-directors Professors Chisholm and Hodges. More information about Terrascope can be found online at http://web.mit.edu/terrascope/.

Faculty

John Grotzinger was elected to the National Academy of Sciences. Carl Wunsch was elected a foreign member of the Royal Society of London (FRS). Sam Bowring was appointed by the provost to the Breene M. Kerr chair in geology. Ed Boyle will be editor of Earth and Planetary Science Letters for the next three years. Rafael Bras was selected to be the Kisiel Lecturer at the University of Arizona, and is incoming chair of the faculty, president elect of the AGU Hydrology Section, and incoming vice president of the Alumni Association. Clark Burchfiel will become president of the Geological Society of America in October 2002. Kerry Emanuel will serve as editor of the Journal of Atmospheric Sciences beginning January 1, 2003. Brian Evans received an outstanding achievement award from the University of Minnesota Alumni Foundation. Tim Grove was elected a fellow of the American Geophysical Union (AGU). James Hansen received the Office of Naval Research Young Investigator award. Kip Hodges was selected as a MacVicar Faculty Fellow, and as the co-director (with Penny Chisholm of CEE) of the new Earth Systems Initiative and the new Terrascope Freshman Program. Professor Lindzen has been listed by *Current Contents* as one of the highly cited researchers. Mario Molina was awarded the 2002 Medal to the Citizen of Merit from the Mexico City Government and was elected a fellow of the American Association for the Advancement of Science. Professor Molina also

received honorary degrees from University of Waterloo, Florida International University, Utah State University and Universidad de Pachuca, Mexico. Alan Plumb was selected to be the Haurwitz Memorial Lecturer by the American Meteorological Society and was elected a fellow of the American Meteorological Society in January 2002. Ronald Prinn was elected a fellow of the American Association for the Advancement of Science. Paola Malanotte-Rizzoli was elected a fellow of the American Meteorological Society in January 2002. Julian Sachs was awarded the Jeptha H. and Emily V. Wade Award by the MIT provost on June 5, 2001. Roger Summons was awarded the Australian Organic Geochemistry Medal in March 2002. Maria Zuber was named a Sverdrup visiting scholar in the Department of Physics at Augsburg College in April 2002.

Over the past two years, several vigorous searches have led to five exciting new faculty appointments. Roger Summons, whose work in "molecular fossils" is widely recognized and lauded, has been appointed professor of geobiology. Julian Sachs, an accomplished young paleoclimatologist, has joined the faculty as the Doherty assistant professor. David Mohrig, who has made notable contributions to sedimentary geomorphology, was named assistant professor of geology. James Hansen, who is doing innovative research on optimal observing and forecasting, has joined us as assistant professor of atmospheric science. Most recently, Raffaele Ferrari, who is an expert in the dynamics of small-scale circulations in the ocean, was appointed as assistant professor in physical oceanography.

The department currently has active faculty searches in six exciting areas: planetary science, experimental geophysics and geochemistry, seismology, geobiology, atmospheric chemistry, and low temperature geochemistry. These searches, along with the appointments already made, are laying the foundation for the department's future.

The department continues to pioneer work in new interdisciplinary areas. The Earth Resources Laboratory is broadening its base to include a wider range of geophysical, geological, and environmental topics. The Center for Global Change Science (including the Climate Modeling Initiative) and the Program in Atmospheric, Oceans and Climate continue to foster cross-fertilization among all areas of the earth sciences that control the climate system. Research activities are broadening so that geologists are now working with oceanographers and atmospheric scientists, and models of the climate system have been constructed both for the modern system and for times deep in the geological past. A large new faculty group interested in co-evolution of the geosphere and biosphere has formed and is participating in the Earth Systems Initiative noted earlier. Department faculty also continue to play leading roles in the MIT Joint Program on the Science and Policy of Global Change.

Current Research

Edward Boyle's group has documented a dramatic decline of lead in the North Atlantic in response to the phasing out of leaded gasoline. The unique isotopic signature of the changing sources of lead shows that the water at the bottom of the eastern North Atlantic sank from the surface 80 years ago.

Clark Burchfiel's group is studying the Cenozoic post collisional intracontinental tectonic evolution of the Tibetan plateau including GPS studies of active crustal movements correlated with active deformation. Tectonic studies in Bulgaria and Macedonia are also proceeding.

Jim Elliot, Susan Kern (graduate student), and their colleagues at Lowell Observatory continued their Deep Ecliptic Survey for Kuiper Belt objects and Centaurs to understand their evolution. They have achieved 40 percent of their goal of discovering a sample of 500 new bodies.

Kerry Emanuel has been studying the physics of air-sea interaction at very high wind speeds, and the role of global tropical cyclone activity in controlling the ocean's thermohaline circulation and, thereby, global climate.

Brian Evans, Visiting Professor Yves Bernabe, and Uli Mok, working on fluid flow and deformation, found that the evolution of permeability of rocks during natural processes is a unique function of the mechanism of porosity change.

Glenn Fleirl and his students have examined the growth of disturbances in time-dependent tidal flows and shown that these can amplify and lead to turbulence. These flows could, along with swarming behavior, effect concentrations of zooplankton in Cape Cod Bay.

Frederick Frey is involved in the Hawaii Scientific Drilling Project, which is drilling Mauna Kea volcano to a depth of 3,100 m. He shows how the magma sources and melting process, and the decreasing extent of melting with decreasing eruption age, changed systematically as this volcano moved away from the hotspot.

Tim Grove and his colleagues have developed a flux-melting model for magma generation in subduction zones. Water is released from the cold subducted oceanic lithosphere, rises into hotter overlying mantle, lowering the melting point of peridotite and resulting in the generation of H_2O-rich magmas.

Brad Hager, student Linda T. Elkins Tanton, and Grove found that impact by giant meteorites can lead to flood basalts on the moon and earth. Crater excavation via removal of ejecta leads to immediate pressure-release melting, perhaps followed by prolonged secondary eruptions due to small-scale convection.

James Hansen has been working on prediction and predictability, with special interest in the impact and possible exploitation of model inadequacies in probabilistic state estimation and forecasting.

Thomas Herring has been using global positioning system (GPS) and very long baseline interferometry (VLBI) data to develop geophysically based models of changes in the rotation of the earth and earth deformation on global and regional scales.

Kip Hodges' group has been exploring neotectonic activity and the development of Himalayan topography, and continental subduction in Eocene time in the Indian Himalayas. A new excimer laser microprobe will provide the capacity for high-spatial resolution mapping of Ar and He isotopic distributions in single crystals.

Richard Lindzen's recent research has focused on the possibility of a very strong negative climate feedback involving tropical clouds, the mechanisms whereby the atmosphere's major heat transporting eddies equilibrate, and the ways in which tropical waves and deep convection interact.

John Marshall has focused attention on the Antarctic Circumpolar Current of the ocean, developing theories of its meridional overturning circulation, which is a central component of the global climate system.

David Mohrig focuses on the evolution of terrestrial and submarine landscapes over long time scales (>10,000 years) through the study of sedimentary record. His laboratory experiments are helping to understand evolution of submarine channels.

Mario Molina and Luisa Molina have continued to develop the Mexico City Project, including a February 2002 measurement campaign. Their laboratory studies show that organic particles react relatively fast with the hydroxyl radical.

Dale Morgan's group works on induced polarization, self-potential, and resistivity imaging for a groundwater and contaminant mapping. They completed groundwater mapping in Curacao and imaging at the DOE Savannah River Site.

Reginald Newell is analyzing observations collected by two aircraft during the 2001 spring. A relationship between atmospheric spin and ozone is being studied to find the level of ozone origination.

Alan Plumb and his group are working on: modeling and theory of stratospheric transport; dynamical linkage between stratosphere and troposphere; monsoon modeling; and, in collaboration with Professor Marshall, ocean eddy transport processes.

Ronald Prinn and his students and research scientists have completed studies which have elucidated trace gas production by oceanic phytoplankton, better defined the chemistry of dimethyl sulfide, and examined new gases for OH estimation.

Paola Malanotte-Rizzoli and her group worked on: exchanges between the subtropical and the tropical ocean and how these interactions affect the global thermohaline circulation; new approaches for model simulation of the ocean circulation; and biochemical/physical models for the Black Sea ecosystem.

Daniel Rothman and his group have shown that the regular spacing of channels initiated by subsurface flows in diverse settings is caused by an intrinsic dynamical mechanism, and that the spacing itself decreases with increasing slope and pressure gradient.

Julian Sachs has been measuring organic chemicals and their isotope ratios in marine sediments and polar ice to provide estimates of sea surface temperatures, wind speeds and ocean productivity in the last 450,000 years. The data aids understanding of the causes of abrupt climate change.

Peter Stone, Ronald Prinn, and their colleagues have completed the first quantitative analysis of the uncertainties in projections of global warming. They find that the most probable increase in global mean temperature from 1990 to 2100 is 2.4 C, with a 95 percent probability range of 0.9 to 5.3 C.

Roger Summons, is studying the chemical and carbon isotopic composition of lipids from cultured microbes, environmental samples, and their fossil analogues in ancient sedimentary environments in order to document and understand the nature of Earth's early microbial life.

Nafi Toksöz and his team are working on seismic tomography of the earth's crust in the Middle East and Asia to locate more precisely earthquakes and possible explosions to support international monitoring of the Comprehensive Test Ban Treaty (CTBT).

Rob van der Hilst used a novel wavelet approach to integrate constraints from seismic wave propagation and from gravity-topography coherence to help understand the structure, deformation and mechanical strength of continental lithosphere on different time scales.

Kelin Whipple has been working on relationships between climate and elevation and mountain range evolution. His minimum estimates of landscape response time argue against the often-invoked steady-state assumption, and a river incision law was refined to predict patterns and rates of tectonic uplift.

Carl Wunsch is shifting much of his oceanographic research toward understanding what observations say about the nature of the ocean circulation in the geological past, bringing to bear modern data analysis tools and dynamical ideas.

Maria Zuber and colleagues used altimetry data from the Mars Global Surveyor to measure variations in the depth of CO_2 "snow" on Mars. They also measured small variations

in the planet's gravity field, which combined with surface elevation changes, provided the first estimate of the density of condensed CO_2 on Mars.

Ronald G. Prinn
Department Head
TEPCO Professor of Atmospheric Chemistry

More information about the Department of Earth, Atmospheric and Planetary Sciences can be found on the web at http://www.eaps.mit.edu/.

Department of Mathematics

The Department of Mathematics at MIT seeks to improve upon its top ranking in both research and teaching by aggressively hiring the very best faculty, with special attention to the recruitment of top women and underrepresented minority candidates, and by continuing to serve the broad and varied educational needs of its graduate students, the mathematics majors, and all undergraduates of the Institute.

Students

During the academic year 2001–2002, there were 294 undergraduates majoring in mathematics: 247 in Course XVIII, Mathematics, and 47 in Course XVIII-C, Mathematics/Computer Science. Bachelor of science degrees, including double majors, were awarded to 84 students: 75 in Course XVIII and nine in Course XVIII–C. There were a total of 120 graduate students in mathematics, all in the PhD program. This year 21 students received the doctoral degree.

Faculty Changes

Associate professor Gigliola Staffilani joins the department as associate professor with tenure from Stanford University. She is an analyst specialized in dispersive nonlinear partial differential equations.

Associate professors Bonnie Berger (computational molecular biology), Alan Edelman (numerical analysis) and Michel Goemans (operations research) were promoted to professor.

Assistant professors Sara Billey (algebraic combinatorics), John Bush (fluid dynamics), and Daniel Spielman (theoretical computer science) were promoted to associate professor.

CLE Moore instructors Denis Auroux (symplectic geometry) and Jeff Viaclovsky (geometric pde's) were promoted to assistant professor, and Dmitriy Panchenko will join the department as assistant professor. His specialization is in probability theory and mathematical statistics, and he is a graduate of Novosibirsk State University and the University of New Mexico.

Professor Harvey Greenspan retired from MIT in January 2002 after 40 years of distinguished service.

Assistant professor Lucia Caporaso resigned from MIT for a faculty position at the University of Rome "Roma Tre."

Assistant professor Andras Szenes also resigned from MIT for a faculty position at the Institute of Mathematics, Budapest University of Technology and Economics.

Administration

Professor Michael Artin will continue as chair of the Undergraduate Committee and Professor Michael Sipser as chair of the Committee of Advisors. Associate professor Pavel Etingof will follow Professor Tomasz Mrowka as chair of the Graduate Student Committee; Professor David Jerison will succeed Professor Richard Melrose as chair of the Pure Mathematics Committee, and Professor Ruben Rosales will follow Professor Daniel Kleitman as chair of the Applied Mathematics Committee.

Research

Here are a few snippets from the great range of research underway in the department.

Daniel Freedman has begun to study string theory in a PP-wave geometry. Stimulated by recent work by J.M. Maldacena and others postulating a new and direct connection between gauge field theory and string theory, Professor Freedman with collaborators has proposed a specific identification in field theory of the basic 3-string interaction and has obtained a non-trivial consistency check of this proposal.

Steven Kleiman, with Eduardo Esteves, proved a new upper bound on the arithmetic genus of a closed algebraic leaf of a foliation.

Pavel Etingof and CLE Moore instructor Victor Ostrik, jointly with Dmitry Nikshych, developed a general theory of fusion categories and the theory of Frobenius-Perron dimensions of such categories.

Martin Bazant is publishing a series of articles on "the stochastic renormalization group," which is a broad generalization of usual renormalization group to describe probability distributions of various quantities in phase transitions.

András Vasy is investigating connections between his prior work in quantum many-body scattering (an inherently analytic field) and scattering theory on symmetric spaces (a field with a rich algebraic structure).

Six MIT undergraduates participated with four mathematics graduate-student mentors in the department's fifth Summer Program in Undergraduate Research (SPUR), which offers a six-week program of full-time research experience culminating in written papers and lectures to faculty.

Summer 2001 was the ninth year of the Mathematics Department's participation in the Research Science Institute program for gifted high school students, in which fourteen mathematics graduate students mentored 22 high school students from the US and abroad for a five week period. The mentored students included two of the

top ten finishers in the Intel Science Talent Search for 2001, and one of the six winners of the National Siemens Westinghouse Science and Technology Competition.

Honors and Awards

Faculty

Michael Artin received the Leroy P. Steele Prize for Lifetime Achievement of the American Mathematical Society for "contributions to commutative and non-commutative algebra and ring theory as well as to modern algebraic geometry." Daniel Freedman has been selected to give the Andrejewski Lectures in Leipzig and Berlin in summer 2003. Michael Hopkins was elected a fellow of the American Academy of Arts and Sciences and a foreign member of the Royal Netherlands Academy of Arts and Sciences. Steven Kleiman was elected a foreign member of the Norwegian Academy of Science and Letters, which also hosted a conference on the occasion of his 60th birthday. Haynes Miller was awarded a Cambridge-MIT fellowship for AY2003. Daniel Stroock was named the first holder of the second Simons Professorship of Mathematics. Martin Bazant was awarded the Paris Science chair, a visiting professorship at École Superieure de Physique et Chimie Industrielles, for the fall 2002 term. John Bush received an NSF Career

Award for fluid dynamics. András Vasy and Santosh Vempala received an Alfred P. Sloan Research Fellowship.

Seven of our faculty are invited speakers at the 2002 International Congress of Mathematicians this summer in Beijing, China: plenary lectures to be given by Michael Hopkins, Victor Kac and Gang Tian; invited lectures to be given by Hubert Bray, Pavel Etingof, Lars Hesselholt, and Daniel Spielman.

Students

The Housman Graduate Student Teaching Award was presented to John Dunagan, and a second shared by Baochi Nguyen and Igor Pavlovsky, for their exceptional skill and dedication to teaching. Ryan O'Donnell and Donald Yau were awarded the Charles W. and Jennifer C. Johnson Prize for an outstanding research paper accepted in a major journal by a graduate student in mathematics. The Clay Mathematics Institute selected Tara Holm, Kevin McGerty, and Aleksey Zinger for its Liftoff postdoctoral research program for summer 2002. Jing-Rebecca Li, a 2001 doctoral graduate, received the Householder Prize for the best dissertation in numerical algebra between January 1999 and December 2001.

Senior Abhinav Kumar was awarded the Jon A. Bucsela Prize in mathematics in recognition of distinguished scholastic achievement. Among those seniors awarded degrees in mathematics, 15 were elected to Phi Beta Kappa.

The MIT Mathematics team, comprised of freshman Reid Barton, senior Abhinav Kumar, and junior Pavlo Pylyavskyy, finished second in the 2001 William Lowell Putnam Intercollegiate Mathematical Competition. Reid Barton was among the five highest ranking individuals and was therefore designated a Putnam Fellow. MIT had seven other individual scores in the top 26, and another four individuals were given honorable mention for finishing in the top 61.

Education

The project "Computer Aided Teaching of Mathematics," developed by Professors David Jerison, Haynes Miller, and Gilbert Strang with the support of the D'Arbeloff grant, is making considerable progress and setting a high standard for mathematics courseware design. The goals are twofold: to broaden the active learning experiences of the classroom through visualization tools which can be student-manipulated, and to design tools to interact closely with other MIT courses, such that students can use them throughout their MIT educational careers.

Through the generous sponsorship of the Akamai Educational Foundation and the Mathematical Association of America, the Mathematics Department hosted 200 high school students competing for positions on the US team for the International Mathematical Olympiad. The students were introduced to MIT through tours arranged by the Admissions Office and a picnic luncheon arranged by the mathematics department.

David A. Vogan, Jr.
Department Head
Professor of Mathematics

More information about the Mathematics Department can be found on the web at http://www-math.mit.edu/.

Department of Physics

The Department of Physics has been a national resource since the turn of the century. It has been at the center of the twentieth-century revolution in understanding the nature of matter and energy and the dynamics of the cosmos. Department faculty—three of whom hold Nobel Prizes and 23 of whom are members of the National Academy of Sciences—include leaders in nearly every major area of physics. The department is currently ranked number one for PhD programs by *US News & World Report*.

Honors and Awards

The following Physics faculty members received recognition from the outside community in the last year: Ulrich Becker received a recognition letter from NASA for success in the first AMS flight; Mildred Dresselhaus received a medal of achievement in carbon science and technology from the American Carbon Society; Jerome Friedman received an honorary doctorate from the State University of New York; Mehran Kardar was recipient of both the John Simon Guggenheim Fellowship and a prestigious Miller visiting professorship at the University of California, Berkeley; Wolfgang Ketterle won the Nobel Prize in physics 2001, was elected foreign associate of the National Academy of Sciences, and presented both the Bodo von Borries Lecture at the University of Tübingen and the Konopinski Public Lecture at Indiana University; Daniel Kleppner was inducted into the Academy of Sciences of the Institute of France and asked to present the prestigious National Academy of Science's Robertson Memorial Lecture; Gunther Roland received the US Department of Energy Outstanding Junior Investigator Award; Paul Schechter received a John Simon Guggenheim Fellowship; Senthil Todadri received the Alfred P. Sloan Research Fellowship; Frank Wilczek was named the editor-in-chief for *Annals of Physics*, received an honorary doctorate from the University of Montreal, and received the Michelson-Morley Prize from Case Western University.

In addition, the following faculty members received recognition of their accomplishments at MIT: Deepto Chakrabarty received the 2001 Buechner Teaching Prize in physics. Thomas Greytak was named a Cambridge University MIT Institute Fellow in recognition of his significant contributions to and interest in the CMI Student Exchange; Jacqueline Hewitt became director of the Center for Space Research; Erich Ippen was awarded the James R. Killian, Jr., Faculty Achievement Award; former vice president for research David Litster was awarded the Irwin Sizer Award for the most significant improvement in MIT education; and David Pritchard was awarded the Cecil and Ida Green Professorship of Physics; Alexander van Oudenaarden was named the Keck career development professor in biomedical engineering; and Barton Zweibach received the Everett Moore Baker Memorial Award for excellence in undergraduate teaching.

Assistant professor Haiyan Gao was promoted to associate professor, assistant professor Washington Taylor was promoted to associate professor with tenure and then to full professor, and tenured associate professor Boleslaw Wyslouch was promoted to full professor. Joint appointments were made for Professor Daniel Freedman from the Mathematics Department and assistant professor Leonid Mirny, from the Division of Health Sciences and Technology. New faculty members in the department are assistant professors Eric Hudson, Scott Hughes, and Iain Stewart and adjunct professor David Moncton. Visting professor Sekazi Mtingwa was appointed a Martin Luther King Jr. visiting professor for AY2002 and will continue in this position for AY2003. In January 2003, Arlie Peters, currently an associate professor at Duke University, will join the department as an Martin Luther King Jr. visiting professor.

Education

We have begun implementing a plan to move most of freshman physics away from the standard lecture-recitation format. In the new TEAL (Technology Enabled Active Learning) format developed by John Belcher, students work together in groups of three in an open classroom environment. Each group has a computer and their own set of tabletop experiments. During a typical class the students may do experiments, take data and analyze the results, or watch more elaborate experiments done by the instructor and download the data. They may also watch video clips, simulations, or visualizations projected on screens around the room. Students are expected to have studied the text before coming to class, but the instructor may give mini-lectures about difficult concepts or special topics. A discussion may follow during which students can work at white boards around the room and have their work picked up by a video camera and displayed for the entire class. A specially designed TEAL classroom was opened in September 2001 on the site of the former physics reading room on the first floor of Building 26. The first experience with TEAL was in 8.02 Electricity and Magnetism during the fall 2001 semester. There were two classes with about 90 students in each. By all measures the classes were a great success. The format will be used again in fall 2002, and for the first time with the large 8.02 offering in spring 2003.

The serious decline in physics majors at MIT has been reversed by introducing a new degree program, VIII-B, leading to a bachelor of science in physics. VIII-B requires fewer specific upper-level subjects in physics than our traditional VIII program. VIII-B students choose a coherent set of three "focus" subjects that build on a physics foundation. We designed this new degree path to appeal to students who enjoyed physics but did not plan to go on for a PhD in physics, in particular those who wished to follow non-traditional career paths. To our surprise we

found that the freedom of choice offered by the program was also attractive to students who *did* expect to pursue a doctorate in physics. In 2001, the first year the new program was offered, the number of SB degrees in physics rose to 54 from the previous year's 35. The number relaxed a bit in 2002 to 47, but this does not take into account an anomalously large number students who have chosen to remain at MIT for a fifth year, many of them completing a second or third degree.

Diversity

The Department of Physics is in the forefront in producing minority PhDs. To recruit new minority graduate students, the department continues to support students' membership in the National Conference of Black Physics Students (NCBPS) and the National Society of Black Physicists (NSBP). The department continues to support North American under-represented scholars through the Physics Department Head fellowships. The department continues to fund all travel expenses for underrepresented North American candidates, as well as all North American female candidates. Despite these efforts, the pool of qualified minority candidates for graduate school remains extremely small, and the qualified students are aggressively recruited by the competition. To further our goals, we are working with MLK visiting professor and former MIT alum Sekazi Mtingwa to identify additional methods to increase the diversity of our community. Towards this end, the department has retained the services of a minority-owned search firm specializing in the recruitment of underrepresented minorities in the sciences.

Our percentage of women is higher than for most institutions, but still quite small. We support the Women in Physics group, which consists of current female graduate students, by providing space and funding for bi-weekly dinners and other events. The group actively recruits female candidates to the program (i.e., they host a reception during Open House for female candidates and they telephone individual female candidates). This year, they organized a dinner open to all undergraduates to discuss graduate school in physics, physics research at MIT and career choices in general. The event was so successful that it will be held annually. In addition, beginning this fall we are going to initiate a mentoring program for female undergraduate physics majors at MIT. The program was developed to foster a closer interaction between undergraduate and graduate physics students to benefit both groups of women. All these activities are listed on their web site http://web.mit.edu/physics/wphys/ This group also receives financial support from a generous alumna of our department.

In sum, the department continues to aggressively recruit and retain underrepresented minorities and women to the department.

Pappalardo Fellowships in Physics

In 2000, Mr. A. Neil Pappalardo, EE '64, provided the funds to initiate and sustain a program for physics fellows, the Pappalardo Fellowships in Physics. He recognized that one of the features that distinguish the sciences in general, and physics in particular, is the importance of the accomplishments of outstanding individuals. Thus, the mission of the Pappalardo Fellowships in Physics is to sustain a preeminent postdoctoral program that identifies, recruits and supports the most talented and promising young physicists at an early stage in their careers. The program appoints three new fellows per academic year for three-year terms, up to a maximum membership of nine fellows. The fellows enjoy unrestricted choice of research direction; active faculty mentoring through weekly luncheons and monthly dinners designed to foster scientific exchange and promote professional growth; a competitive annual stipend with a built-in cost-of-living increase combined with $5,000 per year discretionary funds; and health insurance coverage for fellows and their dependents.

Research Highlights

Noisy Genes

Noise is often perceived as being undesirable and unpredictable. The experimental physicist spends a lot of time trying to lower the noise floor of the experimental setup to a level that enables the detection of tiny signals. In biology, however, noise is intrinsic to living systems and cannot be controlled by the experimentalist. Living systems are inherently noisy, and are optimized to function in the presence of fluctuations. In this context, evolution plays the role of the experimentalist in trying to control the noise. During evolution biological cells have been fine tuned and optimized to function in noisy environments, but it's not clear what the biological function of noise is. Does noise increase or decrease the fitness of a cell? In the van Oudenaarden group, we both develop theoretical models and conduct quantitative experiments to elucidate the functional role of noise in genetic and biochemical reactions. (Adapted from "Noisy Genes" by Professor Alexander van Oudenaarden, *physics@mit* Fall 2002.)

Inflation and the New Era of High-Precision Cosmology

During the past five years, our view of the universe has been jolted by several new and surprising observations. Instead of slowing due to gravitational attraction, the expansion of the universe has found to be speeding up! Shortly afterward, new measurements of the cosmic background radiation overturned the prevailing beliefs about the geometry and total mass density of the universe. According to the *New York Times* of November 26, 1999, "Like the great navigators who first sailed around the world, establishing its size and the curvature of its surface, astronomers have made new observations that show

with startling directness the large-scale geometry of the universe and the total amount of matter and energy that it contains.... All the data are consistent with a flat universe, said scientists on the projects and others who have read the teams' reports." The combined results of these observations have led to a new picture of our universe, in which the dominant ingredient is a mysterious substance dubbed "dark energy." The second most abundant material is "dark matter," and the ordinary matter that we are made of has been relegated to third place. Although substantially different from what was believed just a few years before, the new picture is beautifully consistent with the predictions of inflationary cosmology. (Adapted from "Inflation and the New Era of High-Precision Cosmology" by Professor Alan H. Guth, *physics@mit* Fall 2002.)

Marc Kastner
Department Head
Donner Professor of Science

More information on the Physics Department can be found online at http://web.mit.edu/physics/.

Center for Cancer Research

The Center for Cancer Research was established in 1973 to study fundamental biological processes related to cancer. The goals of the center's research can be generally stated as developing an understanding of the genetic and molecular basis of cancer, how alterations in cellular processes affect cell growth and behavior leading to cancer and other diseases, and how the immune system develops and recognizes antigens. These goals are related to the center's major research programs in cancer-associated genes and mammalian genetics; molecular, cellular and developmental biology; and immunology. Approximately 248 people work in the center, distributed among the research laboratories of 13 faculty members. In addition, six faculty members in the Whitehead Institute, four in Biology, one in Chemistry and two in the Biological Engineering Division are affiliate members of the CCR.

Financial support for research in the center comes from many sources. The core of this support, which provides much of the funds for administration, partial support for new faculty, and central research facilities (i.e. glass washing facility, media preparation and other specialized laboratories), is a center core grant from the National Cancer Institute. The current term extends to April 30, 2005. In addition to the core grant, the center's faculty have a total of 39 fully funded projects (plus >$809,000 in sponsored funds, primarily in the form of fellowships for postgraduate studies). This competitive support comes largely from the National Institutes of Health and the Howard Hughes Medical Institute, from industry, and from a variety of foundations supporting research in particular disease areas (American Cancer Society, Hereditary Disease Foundation, Muscular Dystrophy Association, National Neurofibromatosis Foundation, CaPCURE, Arthritis Foundation, etc.). This latter type of support is particularly valuable for starting projects which later mature into federally funded grants. The center's success in attracting grant support is a reflection of the excellence of the research and educational activities of its faculty members. The FY2002 research volume was approximately $12.7 million, which does not include $4.7 million in additional support from the Howard Hughes Medical Institute.

Several groups in the center study the identities and functions of oncogenes and tumor suppressor genes. This work includes the development of sophisticated mouse models of cancer development as well as basic molecular studies on other oncogenes and tumor suppressor genes that regulate gene expression controlling the cell cycle and tumor growth. Another focus is on the biochemical mechanisms controlling RNA transcription and splicing and the newly discovered process of RNA interference (RNAi).

The immunologists in the center study the development of cytotoxic and helper T lymphocytes, their antigen-specific receptors, and the molecular mechanisms of antigen presentation. The development and memory properties of B and T cells is also under study as well as the process of tolerance defects which can lead to autoimmune disease. Since the immune response to tumors is poorly understood, these basic studies are crucial to a more profound analysis of tumor rejection. Immune cells can destroy cancer cells and it may be possible to stimulate this process. Furthermore antibodies to tumor antigens are proving very successful in tumor therapy.

The cell biologists study cell surface proteins involved in cellular adhesion and migration, as well as cytoskeletal proteins involved in cell motility and shape. Alterations in cell adhesion proteins contribute to the malignant phenotype of tumor cells including involvement in invasion, metastasis and angiogenesis. These proteins as well as cytoskeletal proteins are important targets for antitumor drugs, and deeper understanding of their structure and function should contribute to better therapeutic agents.

Since the cellular processes of development and cancer have much in common, useful insights into the behavior of tumor cells can be obtained from studies of normal embryos; several projects in the center focus on developmental processes. Recent advances in the generation of transgenic mice and mice with mutations in targeted genes are being exploited to investigate the roles of a variety of proteins important in tumorigenesis, including oncogene proteins, tumor suppressor genes, cell adhesion receptors, T-cell receptors and protein kinases. A large-scale insertional genetics strategy in zebrafish is yielding new genes with essential roles in early vertebrate development.

The center has been instrumental in establishing the BiomicroCenter and several research projects are using increasingly powerful tools in gene expression analysis, proteomics and bioinformatics to address complex mechanisms in proliferation control, checkpoint function, and tumorigenesis.

Research Advances

The Jacks lab continues to develop important new mouse models for cancer, including a powerful new model of lung cancer.

The Yaffe lab has used a combination of biochemistry and bioinformatics to define a function for the PX domain of proteins involved in phagocytic cell function. Their work explains the effects of mutations in patients with granulomatous disease.

The Hynes lab has shown that tumors comprised of cells lacking a key cell surface receptor have reduced blood vessels and growth properties.

The Sharp lab has used RNA interference methods to inhibit the replication of the virus that causes AIDS, HIV.

The Amon lab has discovered a new regulatory network in yeast cells that controls a critical transition in the cell division cycle.

The Hopkins lab has completed their insertional mutagenesis screen in zebrafish and has identified seventy-five genes involved in early development in this vertebrate organism.

In addition to its strengths in basic research, the CCR performs an important role in training future researchers in biomedical science, including undergraduate and graduate students, postdoctoral and clinical fellows. The faculty of the center fulfill critical roles in the educational programs of the Department of Biology. Extensive collaborations exist with medical schools, hospitals and the biotechnology/pharmaceutical industries. Thus, the research in the CCR has a major impact both on the fundamental understanding of cancer and on translation to and from the clinical arena.

To further the goal of bringing cutting-edge research to the cancer research community in the greater Boston area, the CCR hosted, on June 21, 2002, its first annual scientific symposium on the molecular basis of cancer, entitled Invasion and Metastasis. This inaugural symposium featured eight internationally renowned cancer researchers and was dedicated to Dr. Richard Hynes in recognition of his accomplishments in the field of cancer research and in appreciation of the decade of service and leadership he provided as director of the center from 1991-2001.

A major strength of the center remains its attractiveness as an environment for the training of young scientists. The center has 41 graduate and undergraduate students and 57 postdoctoral fellows/associates.

Honors and Awards

It is a pleasure to report the following honors and awards to faculty of the center during this past year:

Tyler Jacks was promoted to investigator of the Howard Hughes Medical Institute and was appointed director of the center in July 2001. He received the Director's Service Award for his service to the National Cancer Institute and the Board of Scientific Advisors and was the seventh annual Verne M. Charpman Lecturer at the Rosewell Park Cancer Institute.

Jacqueline Lees was appointed associate director of the center in July 2001.

Phillip Sharp received the fourth annual Biotechnology Heritage Award from the Biotechnology Industry Organization and the Chemical Heritage Foundation, and was elected an honorary fellow of the Royal Society of Edinburgh, Scotland.

Angelika Amon was promoted to associate professor.

Jianzhu Chen was appointed guest professor at the Institute of Microbiology of the Chinese Academy of Sciences.

Luk Van Parijs received MIT's Westaway Award.

Tyler Jacks
Director
Professor of Biology

More information about the Center for Cancer Research can be found on web at http://web.mit.edu/ccrhq/www/.

Experimental Study Group

The Experimental Study Group (ESG), now in its 32nd year, has grown significantly beyond its original mission of providing personalized instruction in the core subjects to first-year students at MIT. Additional functions include sponsoring a variety of innovative and interactive undergraduate seminars, developing new curricula and pedagogical approaches for core subjects, expanding alumni involvement in ESG and at MIT, and training undergraduates to help teach biology, chemistry, computer science, math, physics, and HASS subjects to freshmen.

These initiatives are not only useful for our own program, but are potentially exportable to the regular curriculum. For example, several seminars developed and taught in ESG (SP287 Kitchen Chemistry and SP293 Robotics) are now being offered as dorm-based seminars to regular-curriculum students. We are working closely with various parts of MIT (including relevant academic departments, the Edgerton Center, Student Life Programs and Housing, and the Dean for Undergraduate Education) to continue these seminars and promote their growth, since they are directly in line with recommendations in the Task Force's Report on Student Life and Learning to better integrate those two aspects of students' lives.

Student Statistics

Fifty-three first-year students enrolled for one or both terms in ESG. ESG's freshmen were a diverse group: 53 percent of students were female, 13 percent were underrepresented minorities, and 9 percent were international students. Twenty-three upperclassmen took one or two core science or HASS subjects in ESG, and 85 undergraduates (78 percent of whom were not former ESG students) took part in our seminar program.

An important component of ESG includes undergraduate, graduate, and alumni teaching assistants who work closely with the staff and faculty in helping maintain the group's ability to offer high-quality, personalized instruction. ESG employed 28 undergraduates (who collectively maintained a grade point average of 4.5) who were closely supervised by staff through a variety of methods, including participating in a weekly teaching seminar in the fall term, meeting regularly with staff members, and receiving written feedback through end of term freshman evaluations. The group also utilized three graduate students (two of whom had been in ESG as freshmen) and two ESG alumni as teaching assistants.

Staff and Faculty

ESG's administration was headed by Professor Travis Merritt and included associate directors Dr. Peter Dourmashkin and Dr. Holly Sweet, and program coordinator Julie Banda. The advisory committee maintains oversight of ESG with faculty representation from the Department of Chemistry (Professor Alan Davison), the Department of Mathematics (Professor Daniel Kleitman), the Department of Physics (Professor Marc Kastner), the School of Humanities, Arts, and Social Sciences (Dean Philip Khoury), and the School of Science (Dean Robert Silbey).

The physics staff was headed by Dr. Peter Dourmashkin (senior lecturer) and included professor emeritus Robert Hulsizer and three ESG alumni—Toby Ayer '96, David Custer '82, and Dr. Sen-Ben Liao '90 (currently on leave from his professorship at National Chung-Cheng University in Taiwan). The mathematics staff was supervised by Dr. John Lewis (senior lecturer) and included ESG alumnus Glenn Iba '74, Evelyne Robidoux, and Craig Watkins.

Dr. Patricia Christie headed the chemistry and biology offerings at ESG. ESG also offered several HASS and HASS-D courses to its students. In the fall term, Matthew Belmonte taught 21W.730 Expository Writing and Dr. Lee Perlman taught 24.00 Problems in Philosophy. In the spring term, Professor Merritt taught 21L.004 Major Poets, Dr. Perlman taught SP2H1 Philosophy of Love, and Mr. Custer taught 21W.735 Reading and Writing the Essay.

Academic Initiatives

Because of its small size and experimental educational focus, ESG provides an ideal milieu in which staff, faculty, and students can develop new subjects and new approaches to existing subjects. The most exciting development has been the steady increase in the numbers of undergraduate seminars we have been able to offer at ESG, most of them supported by gifts from ESG alumni.

This year we offered 10 seminars, five of them developed and taught by undergraduate students under staff and faculty supervision. New seminars this year included SP.270 The Art, Culture, and Industry of Japanese Animation, SP.271 The Rise of Algebraic Thinking, SP.273 Research Seminar on Skill Development in Humans and Computers, SP.274 Political Prisoners: Personalities, Principles, and Politics, and SP.275 Sustainable Living at MIT. The Class of 1951 Fund will be sponsoring SP.270 again in the coming year.

Seminars previously offered include SP.287 Kitchen Chemistry, SP.290 Psychology in Action, SP.292 Writing Workshop, SP.273 Robotics, and 9.A12 Psychology Looks at the First Year.

In the spring term, ESG sponsored over two-thirds of all of the undergraduate seminars offered to the entire undergraduate student body at MIT. Students who take ESG seminars frequently say that these seminars are the only opportunity they have had since their freshman year to participate in a small interpersonal class with a hands-on

focus. We are working on ways to encourage MIT to offer more seminars like these for its upperclassmen.

For the second year in a row, ESG offered its own recitation and tutorials in 6.001 Structure and Interpretation of Computer Programs. Chris Cheng, a current graduate student in Course 6, ran the tutorials, and recitation sections were handled by upperclassmen James Rising, Catherine Russo, and ESG alumnus Emil Sit. The smaller size of the recitation and the close contact between recitation instructor and tutors allowed students to receive more individualized and integrated attention.

Two ESG staff members, Dr. Peter Dourmashkin and Dr. Sen-Ben Liao, have been instrumental in utilizing their experience learning and teaching physics in ESG to help develop student teaching materials for the new TEAL 8.02 subject which was offered this past spring. In addition, Dr. Dourmashkin sponsored a summer camp for middle-school girls in the development of technological skills for the first time this past summer, which included learning how to build go-carts and radio-controlled blimps. This camp is being sponsored again this coming summer.

Alumni Involvement

The ESG Alumni Network (ESGAN) was created in October 1999 in response to requests from alumni who had attended ESG's 30th anniversary celebration that fall. The network allows for more opportunities for interaction with ESG than the standard annual newsletters and occasional reunions. Glenn Iba '74 has served as ESGAN's president since its inception and has been instrumental in expanding the role of alumni at ESG.

During this past year, our alumni have been very involved in many aspects of the ESG program, including teaching subjects for credit, running seminars during IAP, offering internships and job opportunities for students, speaking at Friday luncheons, and participating in community activities (such as weekend trips). ESG alumni also have made significant financial contributions to ESG, which were used to sponsor educational initiatives, and community activities that are beyond the scope of the ESG base budget. It is clear that many ESG alumni feel a strong connection to ESG, and that ESGAN has helped facilitate and strengthen those connections.

Awards

ESG gave its own set of annual cash awards, including the Peter and Sharon Fiekowsky Community Service Award (now in its third year) and the Todd Anderson Excellence in Teaching Award (now in its fifth year). Both Mr. Fiekowsksy and Mr. Anderson are graduates of MIT and have established funding for annual prizes.

This year, the Peter and Sharon Fiekowksy award was won by Jennifer Tu '05 for her outstanding contributions to the ESG community. The Todd Anderson teaching award was given to seniors Miriam Boon, Alexis Cavic, Roger Ford, Toh NeWin, and Eric Smith, who have all demonstrated excellence in teaching at ESG over a sustained period of time.

Future Developments

In the coming year, we plan to continue with our educational innovation—especially offering hands-on education, interdisciplinary subjects, residence-based seminars, and web-based instructional materials—and to promote the use of undergraduates in instructional capacities at MIT. We will continue to expand the use of alumni at ESG, particularly in terms of funding new projects and informally tutoring and mentoring our new students.

We look forward to continuing to provide a unique place where staff, students, faculty, and alumni can come together to experiment with new ways of teaching and learning within a collaborative, intergenerational, and interdisciplinary community.

Travis Merritt, Director and Professor of Literature Emeritus
Peter Dourmashkin, Associate Director and Lecturer in Physics
Holly Sweet, Associate Director

More information about the Experimental Study Group can be found online at http://web.mit.edu/esg/www/home.html.

George R. Harrison Spectroscopy Laboratory

The George Russell Harrison Spectroscopy Laboratory conducts research in modern optics and spectroscopy for the purpose of furthering fundamental knowledge of atoms and molecules and pursuing advanced engineering and biomedical applications. Professor Michael S. Feld is director; Professor Jeffrey I. Steinfeld and Dr. Ramachandra R. Dasari are associate directors. As an interdepartmental laboratory, the Spectroscopy Laboratory encourages participation and collaboration among researchers in various disciplines of science and engineering. Professors Steinfeld and Moungi G. Bawendi, Robert W. Field, Stephen J. Lippard, Keith A. Nelson, Andrei Tokmakoff of the MIT Chemistry Department, Professors Feld and Alexander Van Oudenaarden of the Physics Department, Professor William H. Green of the Chemical Engineering Department, and Dr. Dasari are core investigators.

The laboratory operates two laser resource facilities. The MIT Laser Biomedical Research Center (LBRC), a Biotechnology Resource Center of the National Institutes of Health, develops basic scientific understanding, new techniques and technology for advanced biomedical applications of lasers; core, collaborative and outside research are conducted. The National Science Foundation–supported MIT Laser Research Facility (LRF) provides resources for core research programs in the physical sciences for 11 MIT faculty members from Chemistry, Physics, and Chemical Engineering. Information about the facilities of the LRF and the LBRC can be found in the Spectroscopy Laboratory Researcher's Guide.

Research Highlights

Professor Field and collaborators Anthony Merer (University of British Columbia), Soji Tsuchiya and Nami Yamakita (Japan Women's University), John Stanton (University of Texas), and Fleming Crim and Sarah Henton (University of Wisconsin) have assembled a complete experimental picture of the normal modes, their anharmonic and Coriolis couplings, and the way the trans-cis isomerization barrier is encoded in the spectrum of the first electronically excited singlet state of acetylene. A wide variety of types of spectra were assigned and interpreted within a unified model, which is unique among all other four-atom and larger molecules. One goal of this project is to devise the optimal local-bender "pluck" by which the acetylene<->vinylidene transition state region on the electronic ground state potential surface can be systematically characterized: "transition state spectroscopy."

Professor Field, Dr. Adya Mishra and associates have developed a suite of complementary spectroscopies (surface electron ejection by laser excited metastables, UV-laser induced fluorescence, and photofragment IR-laser-induced fluorescence) and statistical pattern recognition schemes by which the detailed mechanism of intersystem crossing (ISC) in small polyatomic molecules can be characterized. When the ISC is "doorway mediated" a wide range of possibilities for controlling the early time dynamics exist. In a related experiment, a two-photon excitation scheme to produce metastable, electronically excited Hg atoms, which have been used by organic photochemists to populate triplet states of polyatomic molecules, is being developed.

Professor Field and associates, in collaboration with Andrei Tokmakoff (MIT), Dr. Merer, Christian Jungen (University of Paris, Sud), and Frederic Merkt (ETH, Zurich), have developed a one-color femtosecond pump/probe scheme to examine the mechanism of coupling between a molecular ion and an electron in a remote Rydberg orbital. The experiment consists of two ns laser excitation steps to prepare the "launch state", a pair of phase coherent 100 fs pulses to initiate and probe the dynamics, and a combination of pulsed-field ionization and near-infrared photoionization to measure the ratio of populations in the "launch" and "target" state energy regions.

Professors Field and Steinfeld, in collaboration with Dr. Stephen Coy, have extended the IntraCavity Laser Absorption Spectroscopy (ICLAS) instrument to carry out time-resolved measurements. This capability enables kinetic measurements to be carried out on transient weakly absorbing species such as atmospheric free radicals. Preliminary measurements on the HNO radical reacting with molecular oxygen in a discharge flow system were conducted.

Professor Bawendi and Dr. Hans-Jurgen Eisler, collaborating with a group at Los Alamos, have shown that nanocrystal quantum dots are capable of stimulated emission. Furthermore, in collaboration with Professor Henry Smith of the Department of Electrical Engineering and Computer Science, they demonstrated nanocrystal quantum dot lasing, using microcavity resonators. This achievement is a milestone in nanocrystal quantum dot research. Lasing in such systems had been discussed for the last decade, but this was the first demonstration.

Professors Bawendi, Rubner, Jensen, Marc Kastner, and Raymond Ashoori have been investigating the physics of electron conductivity and the effects of charge on nanocrystal quantum dot solids. They discovered a Coulomb glass behavior, resulting in a power law decay of the conductivity of these thin films. They also discovered that charging the dots can control the intensity of the photoluminescence of a film of dots. This discovery is consistent with a previous speculation that dots that contain one electron or one hole are prevented from emitting a photon because of a fast competing Auger process.

Professor Tokmakoff and his colleagues have installed the Spectroscopy Laboratory's new 30 fs titanium-sapphire amplifier, and constructed a mid-infrared optical parametric

amplifier for this system. The mid-infrared pulses will be used to study the molecular dynamics of the hydrogen bond network of liquid water using two-dimensional infrared spectroscopy. Additionally, new methods for acquiring two-dimensional infrared spectra were developed, which apply the phase-cycling methods used in NMR to nonlinear spectroscopic techniques.

Professor Feld and Dr. Christopher Fang-Yen have investigated the many-atom behavior of the cavity QED microlaser. The microlaser was found to display second and third thresholds, which result from an oscillatory gain function and are analogous to first-order phase transitions of the cavity field. Lineshape asymmetries and hysteresis were observed and explained by means of a semiclassical theory including bichromatic interaction with two Doppler-shifted cavity fields.

Professor Nelson and Dr. Christ Glorieux, working collaboratively with Professor Michael D. Fayer and Dr. Gerald Hinze of Stanford University, have completed the development of a novel method for photoacoustic observation of coupling between flow and molecular orientational motion in viscoelastic fluids. In related work, Professor Nelson and his group members used the same photoacoustic measurement method to study mechanical and thermal transport properties of complex materials under high pressure, in diamond or sapphire anvil cells. The method permits direct determination of the equations of state of such materials, of particular interest where structural change including vitrification may occur at elevated pressures.

Professor Katrin Kneipp, together with Drs. Dasari, Harald Kneipp, Kamran Badizadegan, and Charles Boone, and Professor Feld have applied surface enhanced Raman scattering (SERS) inside living cells. Colloidal gold particles 60 nm in diameter were deposited inside cells as "SERS-active nanostructures," resulting in strongly enhanced Raman signals of the chemical constituents of the cells. The new spectroscopic method provides a tool for ultrasensitive and structurally selective detection of chemicals inside a cell, and for monitoring their intracellular distributions. This opens exciting opportunities for cell biology and biomedical studies.

Professor Feld and Drs. Dasari, Charles W. Boone, Annika Enejder, Joseph Gardecki, Irene Georgakoudi, Martin Hunter, and Adam Wax have pursued basic and applied applications of lasers and spectroscopy in biology and medicine at the LBRC. Fluorescence, reflectance, Raman, light scattering spectroscopy, and low coherence interferometry were used for histological and biochemical analysis of tissues, diagnosis and imaging of disease and cell biology applications. Clinical studies were conducted with researchers from the Cleveland Clinic Foundation, the Medical University of South Carolina, Brigham and Women's Hospital, Metrowest Hospital, Beth Israel/ Deaconness Medical Center and Boston University Medical Center. Clinical studies using tri-modal spectroscopy, the combined application of intrinsic fluorescence, diffuse reflectance and light scattering spectroscopies, demonstrated successful diagnosis of dysplasia in Barrett's esophagus, the urinary bladder, adenomatous polyps, the oral cavity and the uterine cervix. Light-scattering spectroscopy was used to measure and image sub-cellular structures much smaller than an optical wavelength. Novel low-coherence interferometry techniques used light at two harmonically-related wavelengths to measure optical phase. Exceedingly small refractive index and length changes, tomographically mapped, were used to study structure and dynamics of cellular organelles. Raman spectroscopy was used to measure blood analytes with clinical accuracy and identify morphology of breast lesions. This experimental and theoretical work is advancing new laser diagnostic technologies in the fields of medicine and cell biology.

Michael S. Feld
Director
Professor of Physics

More information about the George R. Harrison Spectroscopy Laboratory can be found online at http://web.mit.edu/spectroscopy/.

George R. Wallace, Jr., Astrophysical Observatory

The George R. Wallace, Jr., Astrophysical Observatory (WAO) is MIT's local teaching and research optical observatory located in Westford, Massachusetts. Professor James Elliot ('65) is the director, Dr. David Osip ('89) serves as the assistant director/manager, and beginning in the spring of last year, Ms. Chelsey Logan has served as the on-site observatory specialist. Other staff, usually undergraduate student observers and graduate thesis students, are coordinated through research programs. Undergraduates working on the various projects are funded in part by an NSF's Research Experiences for Undergraduates (REU) program and in part by NASA and NSF research grants to Professor Elliot and Dr. Osip.

The site observing facilities consist of a 24-inch reflecting telescope and a 16-inch reflecting telescope, each in their own domes, a four-bay shed with roll-off roof housing three Celestron 14-inch Cassegrain telescopes (C-14) and a computer-controlled Meade 8-inch Cassegrain telescope, and several Celestron 8-inch Cassegrain portable telescopes. Additional infrastructure includes a building housing electronics workshop, data analysis computer facilities, and an office for the observatory specialist.

The primary instrument for the 24-inch telescope has now been upgraded to a high sensitivity back-illuminated CCD camera system from Apogee, mated to a computer-controlled three slot filter slide from Optec. All other telescopes are equipped with CCD (charge-coupled device) camera systems as well and dedicated control computers. Additional instruments used during the past year include several photographic cameras, and a moderate-resolution fiberoptic spectrograph.

A major facility upgrade was completed in the past year at WAO. As part of this process, the entire 24-inch telescope was disassembled for the first time since it was built 30 years ago. A new drive system has been constructed with close-looped encoded stepper-servo motors mated to custom 10:1 reduction gearing for both axes. A new telescope control system known as MOVE (designed originally at Lowell Observatory) has also been implemented. This new drive system allows full computer control of all telescope motions tracking at both sidereal and non-sidereal (for solar system objects) rates with positional accuracy of better than an arcsecond. The primary and secondary mirror have been tested, re-figured, polished, and re-coated; they were re-installed in the newly completed telescope late last summer.

The resulting optical configuration is a substantial improvement over the previous system and should provide excellent seeing limited performance. In late October 2001, the 24-inch telescope was fully reassembled. Over the fall semester and IAP, the telescope balance and motion were refined. The mirrors were laser collimated during the spring semester. Home and limit switches were installed to allow the telescope to move (and stop) under computer control. The camera and filter slide were tested and calibrated in lab and then mounted on the telescope. In the spring semester, and accurate pointing map for the telescope was developed using the Apogee camera at the Cassegrain focus and an additional 5-inch Schmidt-Cassegrain finder scope for initial field corrections. A majority of the telescope upgrade and performance verification of the combined camera/telescope system constituted the master's thesis project of Janet Wu ('00,'02) under the supervision of Dr. Osip and Professor Elliot.

Last summer, PCCD (the portable CCD system that had served as the observatory's workhorse camera for several years) went through its own system upgrades in preparation for an occultation observing campaign (the original purpose for the portable system). Graduate student Michael Person ('94) and undergraduate James Pate ('03) carried out the PCCD work under the supervision of Professor Elliot. The system was then deployed last August in South Africa for observations of the occultation of a star by Neptune's moon, Triton. The results of this successful observing campaign are being incorporated in Person's PhD thesis.

Student participation at the observatory was once again robust over the past year with several organized events with the campus chapter of Students for the Exploration and Development of Space (SEDS). Professor Elliot's fall laboratory course 8.287J-12.410J Observational Techniques of Optical Astronomy drew 14 students, who used the Wallace facilities for a variety of astronomical projects, including broadband imaging of star clusters to construct color-magnitude diagrams and wide-field astrometric imaging of asteroids and planetary satellites. In addition, the new fiberoptic spectrograph systems were used for low and moderate resolution single-target spectroscopy observations. Drs. Andrew Rivkin and Joanna Thomas-Osip offered 12.409 Observing the Stars and Planets in the fall and spring semester, where an additional 20 students used the observatory for laboratory work.

David J. Osip
Assistant Director

More information about the Wallace Astrophysical Observatory can be found online at http://web.mit.edu/wallace/.

Laboratory for Nuclear Science

The Laboratory for Nuclear Science (LNS) provides support for research by faculty and research staff members in the fields of high energy and nuclear physics. These activities include those at the Bates Linear Accelerator Center and in the Center for Theoretical Physics. Almost half of the faculty in the Department of Physics conduct their research through LNS. During fiscal year 2002, the Department of Energy is expected to provide LNS a total of $27,836,000 in research funding.

Experimental High Energy Physics

LNS researchers in experimental high energy physics are active at several laboratories, including SLAC (California) and Fermilab (Illinois). The overall objective of current research in high energy physics is to test as precisely as possible the Standard Model, which has been very successful in describing a wide variety of phenomena, and to seek evidence for physics beyond the Standard Model. LNS researchers are playing principal roles in much of this research, as described below.

LNS researchers are playing leading roles in the BaBar experiment at SLAC, which has yielded important insights into the nature of charge symmetry/parity violation in the B-meson system.

The Collider Detector Facility (CDF) experiment at Fermilab is designed to study the Standard Model and its possible extensions at the highest energy accelerator in the world, the Tevatron collider. Current objectives of CDF include studies of the "bottom" (b) quark, precision measurements of the mass of the W particle (the carrier of the charged electroweak force), and the search for possible quark substructure. After a major upgrade, in which LNS researchers assumed important responsibilities, the multi-year Collider Run II is now beginning to produce data.

In 2007–2008 the high-energy frontier will shift to CERN in Geneva, Switzerland, when the Large Hadron Collider (LHC) commences operation. LNS is involved in both large detector projects at the LHC—viz., the CMS and ATLAS detectors. In CMS, LNS scientists are engaged in the development of the data acquisition system; in ATLAS the effort is mainly in the development of the muon detection systems.

The Alpha Magnetic Spectrometer (AMS) experiment is designed to look for cosmic anti-matter and evidence for dark matter by operating a large magnetic spectrometer above the earth's atmosphere. The international AMS collaboration is composed primarily of particle physicists and is led by an LNS group. An upgraded version of the AMS spectrometer is under construction, and the experiment is scheduled for a several-year data-taking period on the International Space Station starting in 2004.

Experimental Nuclear Physics

Experimental nuclear physics at present has two main thrusts: medium-energy physics and heavy-ion physics. LNS has active, leading groups in both of these sub-fields.

The focus of LNS medium-energy activities is the Bates Linear Accelerator Center, which is operated by LNS for the Department of Energy as a national user facility. Bates has been a premier national and international resource for nuclear and particle physics studies for more than two decades. Continuous (as opposed to pulsed) electron beams in the South Hall Ring have been produced in both storage and stretcher modes. Extracted, stretched beam has been used in two highly successful experiments with the new Out-of-Plane Spectrometer system which probed different aspects of the structure of the proton. The major accomplishments of the past year have been the completion of an experiment on parity-violating electron scattering which probes the role of the "strange" quark in the proton, and the completion of the construction of the BLAST (Bates Large Acceptance Spectrometer Toroid) detector. Together with polarized, stored beams and polarized targets, BLAST is entering its commissioning phase and data of unprecedented quality are expected within a year.

LNS nuclear physics researchers are leading several important efforts at accelerator facilities other than Bates. These facilities include TJNAF (Virginia), LANSCE (New Mexico), DESY (Germany), and Mainz (Germany). The focus of these experiments is a detailed understanding of the properties of the proton, the neutron, and light nuclei.

LNS researchers are prominent in relativistic heavy-ion physics. The principal goal of this field is to probe the existence and properties of the so-called "quark-gluon plasma", a state of matter which is predicted to exist at temperatures and densities higher than those present in normal matter, and which may have been present in the very early universe. An LNS group leads the PHOBOS experiment on the Relativistic Heavy Ion Collider (RHIC) at Brookhaven.

Theoretical Nuclear and Particle Physics

Research at the Center for Theoretical Physics (CTP) seeks to extend and unify our understanding of the fundamental constituents of matter. It seeks to advance the conceptual foundations of fundamental physics, especially as applied to the structure and interactions of hadrons and nuclei, new forms of matter which may be created experimentally or observed astrophysically, and the history and large-scale structure of the universe. A few examples of recent work are mentioned below.

String theory aims to unite the strong, electroweak, and gravitational interactions and to explain the observed hierarchy of particles and interactions. The CTP has a strong and diverse group in string theory with important ties to lower-energy particle physics. Important work includes the study of instabilities of "branes"—extended objects that occur in string theory—and their implications for field theories of strings. CTP theorists are also very active in the exploration of matrix quantum mechanics, which may be the fundamental structure that unifies various versions of string theory, and the study of tantalizing connections between string theories in anti-de-Sitter space and conformal quantum field theories.

String theories suggest patterns of supersymmetry breaking which may have implications for physics at the energy scales of the next accelerators. CTP researchers have been exploring these patterns. Also, string theory and quantum gravity suggest that space-time may have other dimensions, which influence physical phenomena only indirectly. This has been an extremely active area in the past year, largely led by CTP theorists. Effects include manifestations of extra dimensions at energies quite close to those presently available at accelerators.

MIT theorists have been actively developing new calculational tools for the study of non-perturbative effects in quantum field theories. Variational methods, consistent with renormalization and adapted for easy numerical computation, have been developed and are being applied to problems that arise in the standard model.

A major thrust in the CTP has been in the area of lattice gauge theory, which provides a unique tool to solve, rather than model, quantum field theories beyond perturbation theory. The CTP led the development of a major collaboration on high speed computation in QCD, which was recently approved for funding as part of the DOE's SciDAC initiative. These efforts parallel a new thrust in the study of quantum chromodynamics (QCD) at finite density and pressure. CTP researchers have suggested novel effects, such as "color superconductivity", and explained how they may be observed in heavy ion collisions.

CTP researchers continue to lead the exploration of the spin and flavor structure of hadrons, as seen in experiments (many led by MIT faculty) at Bates, Jefferson Lab, DESY, and Brookhaven National Lab.

Finally the CTP has initiated important work in quantum computing. New algorithms that exploit the adiabatic approximation in quantum mechanics offer hope of solving generic problems much faster than classical methods.

Education

Since its founding LNS has placed education at the forefront of its goals. At present approximately 80 graduate students are receiving their training through LNS research programs. A number of undergraduate students are also heavily involved in LNS research. Evidence shows that LNS educates a significant portion of the leaders of nuclear and high-energy physics in this country and abroad.

June L. Matthews
Director
Professor of Physics

More information about the Laboratory for Nuclear Science can be found on the web at http://pierre.mit.edu/.

Picower Center for Learning and Memory

The mission of the Picower Center for Learning and Memory is to understand the complex phenomena of learning and memory and the associated cognitive functions such as perception, attention, and consciousness. Research is focused on analysis of those functions at multiple levels of complexity: the molecular, cellular, synaptic, neuronal ensemble level, and the behavior of the whole living animal. The center's research not only advances our understanding of the brain with regards to learning and memory, but also has broader impacts in diseases such as Alzheimer's, Parkinson's, schizophrenia, depression, and autism.

With a major gift from the Picower Foundation, the center is now poised for an expansion of faculty, added research and support staff, and more graduate and undergraduate students. Anthony Wagner of the Department of Brain and Cognitive Sciences joined the center this year as a faculty affiliate.

Faculty Research Developments

The Hayashia laboratory focused on several projects exploring the molecular biology of excitatory synaptic transmission. They have been working on the molecular mechanisms underlying long-term potentiation (LTP) of the hippocampal CA1 synapse. They previously found that LTP induction delivers AMPA-type glutamate receptors into the synapse, contributing to enhanced transmission. Lab members are currently working to elucidate the detailed molecular mechanism of this phenomenon by combining electrophysiology, two-photon microscopy and molecular biology. They also found a motoneuron specific subunit of the NMDA receptor subunit NR3B and are currently testing if a dysfunction of this receptor causes motoneuron disease represented by amyotrophic lateral sclerosis.

The focus of the Littleton laboratory is to elucidate the molecular mechanisms underlying synapse formation, function and plasticity. They combine molecular biology, protein biochemistry, electrophysiology, and imaging approaches with *Drosophila* genetics to investigate the molecular mechanisms involved in neuronal signaling. Using DNA microarray analysis on conditional mutants in *Drosophila* that induce neuronal hyperexcitation, they have analyzed the Drosophila genome for activity-regulated gene expression in the fly brain. These approaches have allowed them to identify many previously unsuspected candidates for activity-dependent modulation of neuronal function. They are now determining how these genes contribute to cellular forms of behavioral plasticity by analyzing their ability to modulate neuronal function or connectivity. Together, these approaches should greatly expand the understanding of the basic mechanisms of synapse function and plasticity, as well as provide insights into expression changes that allow synaptic ensembles to store information through changes in neuronal connectivity and function.

The focus of the Guosong Liu laboratory is to identify the principles that guide the formation of functional neural circuits. They continue to expand on their previous findings that presynaptic terminals undergo a major period of functional maturation during the initial phase of neural network formation and found several molecules (Shank, BDNF) that play an important role in controlling presynaptic maturation. Recently, this lab has discovered that the excitatory/inhibitory synapse ratio in a single dendritic tree is always conserved and the total amount of excitatory synaptic inputs per dendritic branch is scaled according to the surface area of the tree. Based on these findings, they propose a new rule that governs the organization of synaptic inputs in a dendritic tree.

The Miller lab has made key discoveries of the neural basis of the high-level concepts, abstractions and functions that guide intelligent behavior. In trained monkeys, they have found neural representations of perceptual categories ("cat" vs. "dog"), abstract rules ("same" vs. "different"), and the numbers 1–5, and have also uncovered the neural dynamics underlying short-term memory. This work has resulted in two papers in *Science*, and one each in *Nature*, the *Journal of Neurophysiology*, and the *European Journal of Neuroscience*. They have also published a major theoretical paper in the *Annual Review of Neuroscience*, as well as a number of book chapters and reviews.

The Nedivi lab has been working on characterizing CPG15, a gene they isolated in a forward genetic screen for activity-regulated genes that may play a role in synaptic plasticity. CPG15 encodes a small, highly conserved protein, CPG15, which is attached to the extracellular membrane, and in its membrane-bound form promotes growth of dendritic and axonal arbors, and synapse maturation. They recently discovered the existence of a second form of CPG15 that is secreted as a soluble extracellular molecule. This soluble form of CPG15 has a neuroprotective function, and can protect hippocampal neurons from cell death induced by serum starvation or apoptotic agents. CPG15's mode of action likely interferes with classically defined programmed cell death pathways. Thus, similarly to neurotrophic factors like BDNF and NGF, CPG15 has a dual role in the nervous system. It functions as both a survival factor that can rescue from cell death, and as a growth and differentiation factor that affects process outgrowth. In contrast to the neurotrophins where both functions are performed by the same secreted molecule, in the case of CPG15 the two forms mediate different functions. The soluble extracellular form of CPG15 mediates survival and protection from cell death, while growth and differentiation is mediated by the GPI linked, membrane-attached form.

Morgan Sheng's laboratory is interested in the molecular mechanisms by which synapses in the brain change their strength and connections in response to experience. A major way to strengthen synapses is to deliver more neurotransmitter receptors to the postsynaptic membrane. In the past year, fundamental rules governing the synaptic delivery of one class of glutamate receptor (AMPA receptor) were discovered. In addition, three specific proteins were shown to control the growth of synapses, particularly of dendritic spines (the specialized postsynaptic structures that compartmentalize synapses along the dendrite). A current effort is focused on global "proteomic" analysis of protein changes in synapses during different patterns of neural activity.

Mriganka Sur's laboratory carried out a range of experiments examining the development and plasticity of the cerebral cortex. Using the technique of gene microarrays, postdoctoral fellow Catherine Leamey discovered several genes that mark the initial development of visual and of somatosensory cortex. By recording physiologically from visual cortex in monkeys, postdoctoral fellow Valentin Dragoi discovered that networks of the visual cortex can alter their responses rapidly, on the time scale of visual fixation while scanning scenes, and that such rapid plasticity markedly influences vision.

Research in Susumu Tonegawa's laboratory focuses on the molecular, cellular, and neuronal ensemble mechanisms underlying learning and memory and associated cognitive functions of rodents. Their primary approach is to produce genetically engineered mice and analyze them with multifaceted approaches including molecular and cellular biology, histochemistry, electrophysiology of neuronal culture or brain slices, fluorescence-based microscopy, multielectrode physiology of awake animals and behavioral tasks. During the past few years Tonegawa's laboratory made a ground-breaking discovery in the biological mechanisms of memory recall. It is our real-life experience that the rich content of a memory can be recalled with very limited cues. This phenomenon, referred to as "pattern completion," has fascinated many brain researchers but no underlying biological mechanism has been identified. By creating and analyzing a new strain of mouse in which a specific gene encoding a type of glutamate receptor (called NMDA receptor) is "knocked out" from a tiny brain area called area CA3 of the hippocampus, Tonegawa's laboratory identified a protein and an area of the brain that play a crucial role in memory recall. This work is now published in the prestigious journal Science and drew wide attention, both in the neuroscience community as well as in the popular press.

Matt Wilson's laboratory has continued to focus on the role of the hippocampus in the formation and maintenance of memory in the mammalian nervous system. Recently published work in collaboration with Susumu Tonegawa has demonstrated for the first time, the role of the circuits within hippocampal area CA3 in the retrieval of partially cued memories which represents the manner in which memories are typically accessed in our everyday lives, identifying an explicit physiological correlate of memory retrieval through what is known as "pattern completion" (Nakazawa et al.) They have also advanced their understanding of the mechanisms of sequence memory formation and retrieval with the demonstration of sequence memory reactivation during slow-wave sleep, and identification of cellular mechanisms that could contribute to sequence memory encoding and retrieval (Mehta et al.).

Faculty Honors and Awards

Troy Littleton received a Human Frontier Science Program junior faculty award and an Alfred P. Sloan Research Fellowship.

Earl Miller was promoted to full professor and serves on the following boards: editorial board, *Journal of Neurophysiology*; editorial board, *Behavioral Neuroscience*; editorial board for *Cognitive Sciences*, MIT Press; advisory board, Norwegian International Centre for Research on the Biology of Memory.

Morgan Sheng was elected president of the Society of Chinese Neuroscientists of America.

Mriganka Sur received the Distinguished Alumnus Award of the Indian Institute of Technology, Kanpur, and was named a fellow of the Neuroscience Research Program and a fellow of the National Academy of Sciences, India.

Matt Wilson received a 2002 Picower Scholars Award.

Susumu Tonegawa
Director
Picower Professor of Biology and Neuroscience

More information about the Picower Center for Learning and Memory can be found online at http://web.mit.edu/clm/.

Center for Space Research

The Center for Space Research (CSR) conducts research in astronomy, astrophysics, space science, detector engineering, and related technology, and participates in various National Aeronautical and Space Administration (NASA) flight missions. Specific areas of research include extragalactic astronomy and cosmology, galactic astronomy, the solar system and space plasma physics, and the space life sciences. Research conducted in CSR is reported by the Departments of Physics, Earth Atmospheric and Planetary Sciences, Aeronautics and Astronautics, and Chemical Engineering, and by the Harvard-MIT Division of Health Sciences and Technology.

CSR supports MIT involvement in three major observatories: the Magellan Observatory (Professor Schechter, MIT director), the Laser Interferometric Gravitational-wave Observatory (LIGO; Dr. Shoemaker, MIT director), and the Chandra X-Ray Observatory (CXO; Professor Canizares, associate director). The Magellan consortium is building two 6.5-meter diameter optical telescopes in Chile. The first of these began routine science operations in February 2001. The second saw first light in June 2002 and will begin science operations in September 2002. The LIGO Laboratory, a collaboration of Caltech and MIT, is engaged in developing and commissioning gravitational wave telescopes. The initial LIGO detectors in Washington and Louisiana have come into operation in the past year. R&D continues on next-generation instrumentation for Advanced LIGO, expected to operate at the end of this decade, and for future detectors. The Chandra satellite was launched as a major NASA mission in 1999 and continues to be extremely productive. Two of the four Chandra scientific instruments were built at CSR, the High-Energy Transmission Grating Spectrometer and ACIS, a Charge-Coupled Device (CCD) imaging spectrometer. CSR is also active in the Chandra X-Ray Observatory Science Center (CXC).

In addition to the major observatories, CSR is involved in several more focused space missions. The Rossi X-ray Timing Explorer (RXTE; Dr. Levine, PI) has entered its seventh year of successful operation. CSR's All-Sky Monitor instrument continuously surveys the sky for new sources and guides the activities of other observatories. The HETE-2 mission (Dr. Ricker, PI), built and operated at MIT with US and international collaborators, was launched in 2000 and is dedicated to the detection and prompt localization of the sources of gamma-ray bursts. Construction of detectors for ASTRO-E2 (Dr. Bautz, PI), a reflight of the failed ASTRO-E X-ray spectroscopy mission, is under way. The SPIDR mission was recently selected by NASA as a new SMEX mission. Led by Boston University, with significant contribution from MIT and other institutions, this mission will probe the hot intergalactic ionized gas, believed to be the repository of most of the baryons in the present-day universe.

CSR's Space Nanotechnology Laboratory, directed by Dr. Schattenburg, seeks to apply micro and nanofabrication technology to achieve dramatic improvements in lightweight high-resolution optical components including foil-optic mirrors and diffraction gratings.

CSR is the new home of the astrophysics division of the physics department. Recent renovations have made possible the co-location of nearly all faculty to a common area, bringing together faculty, research staff, postdocs, and students. Students actively participate in research projects; in the past year, 32 graduate students and 29 undergraduate students were supported by CSR.

Extragalactic Astronomy and Cosmology

(Professors Bertschinger, Bradt, Burles, Canizares, Morrison, Schechter; Drs. Arabadjis, Bautz, Crew, Doty, Fang, Ford, Gu, Houck, Lee, Machacek, Marshall, Ricker, Vanderspek, Villasenor, Wise)

Four new gravitational lenses have been discovered with the Magellan telescope. Several of these exhibit flux ratio anomalies which may be evidence for smoothly distributed nonbaryonic dark matter in galaxies. The dynamics of the largest structures in the universe are being investigated with ACIS in studies of cluster merging and cooling and in studies of the kiloparsec-scale jets in active galactic nuclei. A major result from HETG was the first detection of an X-ray absorption line from a modest over-density in the warm-hot intergalactic medium along the line of sight to a distant AGN. In theoretical studies, a new computational approach for the interpretation of cosmic microwave background anisotropies has been developed, and a code for preparing multiscale initial conditions for cosmological simulations has been written and provided to the community.

An important development in the field of GRB studies was the first localization by HETE-2 of a "short-hard" GRB, a type of burst possibly different from the "long" GRBs that have been studied in the past. Vigorous follow-up work with Chandra, Magellan, and other observatories is underway.

Galactic Astronomy

(Professors Bertschinger, Canizares, Chakrabarty, Joss, Lewin, and Rappaport; Drs. Allen, Baganoff, Dewey, Flanagan, Galloway, Huenemoerder, Ishibashi, Jiminez, Lee, Marshall, Morgan, Pannuti, Remillard, Schulz, Wodjowski)

An unprecedented week-long campaign of observations of the galactic center was carried out using most of the world's largest observatories at all wavelengths. New X-ray flares from the black hole were discovered and broadband

spectra of the system were measured. In further studies that probe near the event horizons of black holes, data from the Chandra, RXTE, and XMM observatories show evidence for black hole spin, greatly strengthening the case for the existence of the so-called Kerr black holes. Fast quasiperiodic oscillations from black holes detected by RXTE provide evidence for resonances closely related to relativistic effects and are being compared to fully general relativistic models of hotspots orbiting black holes. RXTE data have also led to the discovery of the third millisecond X-ray pulsar.

High-resolution spectra obtained with HETG have been used to probe the relativistic outflow from galactic microquasars and to study spectral features in X-ray binaries, plasma accretion processes, atmospheres of neutron stars, stellar coronae and winds, supernovae, and young supernova remnants. The properties of supernova remnants and their cosmic ray spectra have been further elucidated by combined radio, X-ray and optical observations. This wealth of new data is being interpreted in light of theoretical modeling. Population synthesis studies of binary star systems containing white dwarfs, neutron stars, and black holes are being carried out in an effort to model cataclysmic variables, low-mass X-ray binaries, binary radio pulsars, and black hole binaries. Detailed new neutron star atmosphere models are being developed, incorporating general relativistic effects and Compton scattering.

The Solar System and Space Plasma Physics

(Professors Pettengill and Belcher; Drs. Ashmall, Chang, Clack, Ford, Jurac, Lazarus, Richardson, Wang)

In recent years, Mars has been the subject of intensive study by a number of instruments. Data from the Laser Altimeter Instrument (MOLA) and the Thermal Emission Spectrometer (TES), both aboard the Mars Global Surveyor, have been used to investigate the atmospheric conditions under which carbon dioxide clouds form and precipitate in the Martial polar night.

Studies of plasma in the solar wind continue from three spacecraft: IMP 8 and Wind, near Earth, and Voyager 2, currently at 65 AU. These studies have demonstrated for the first time the presence of marginal instability limits associated with plasma wave modes, provided an estimate of the density of interstellar hydrogen, and shown a source of OH at Saturn near Enceladus. A high-time-resolution solar wind experiment on the Triana spacecraft is expected to be launched within two years. An innovative theory of complexity in space plasmas in the Earth's magnetosphere and the solar corona has been developed using the concepts of forced and/or self-organized criticality and topological phase transitions.

Human Space Flight

(Professor Young; Drs. Hecht, Oman, Kundakovic, Mast, Natapoff, Vunjak-Novakovic)

CSR has initiated the design of virtual-reality display devices, restraint systems, and software tools for the International Space Station Human Research Facility. The system supports VOILA (Visuomotor and Orientation Investigations in Long Duration Astronauts), a set of flight experiments planned for 2002-2005. The artificial gravity team has made significant progress toward testing short-radius centrifugation with the goal of reducing its unpleasant side effects and putting this more affordable technology within reach as a countermeasure against space deconditioning. Another CSR team is developing the Cell Culture Unit for biological experiments on the Space Station.

Instrumentation for the Future

(Professors Hewitt, Schechter; Drs. Bautz, Levine, Ricker, Schattenburg)

Looking toward future missions, new technology is being developed for advanced X-ray CCD sensors in collaboration with MIT's Lincoln Laboratory. GEM detectors are being adapted for use in space in collaboration with MIT's Laboratory for Nuclear Science. Work continues in the Space Nanotechnology Laboratory on advanced X-ray optics with applications targeted to future missions such as Constellation X and MicroArcsecond X-ray Imaging Mission. An adaptive optics system for Magellan is under development. With colleagues at Haystack Observatory work continues on the development of a large low-frequency array, which will also serve as a prototype for the future Square Kilometer Array.

Jacqueline N. Hewitt
Director
Professor of Physics

More information about the Center for Space Research can be found on the web at http://space.mit.edu/.

Director, Libraries

In the natural life cycle of healthy organizations there are, from time to time, years that stand out as truly extraordinary. Just as the month of June in New England produces furious growth and dramatic flowering in our region's gardens, so too are there times in the life of an organization when everything seems to come into bloom at once. The litany of accomplishments in the MIT Libraries during FY2002 suggests that this fiscal year was such a year. The months were remarkable not only for the sheer volume of positive progress, but also for the fact that change took place on so many different dimensions.

The detailed reports that follow provide ample evidence of the exceptional achievements that characterized the work of the Libraries during FY2002. Even more notable, however, was the degree to which that work represented phenomenal progress toward the strategic goals established for the Libraries in 1999. This strategic plan, available on the web at http://macfadden.mit.edu:9500/lc/sp1999.html, in its fourth year of guiding the direction and priorities of the Libraries, has continued to provide a productive, effective framework for improving library services and operations.

Overview

Almost no aspect of the MIT Libraries organization escaped dramatic progress in FY2002. If the staff of the Libraries seem a bit breathless there is good cause, as the following representative activities illustrate.

With targeted support from the provost, academic deans, and friends, the Libraries' traditional and digital collections were strengthened in both emerging and existing areas of educational and research interest to MIT.

A new library management system was successfully launched, accompanied by a sufficiency of effort, angst, and aggravation. While there is much still to do to capitalize on the full potential of the Aleph system, the choice remains sound and the opportunities exciting. Even as substantial effort went into implementing the new library management system, additional information technology tools were developed and enhanced to serve the networked MIT community.

The Libraries also attended to its collection stewardship responsibilities, with particular regard to the Institute Archives, the government documents depository program, the collections in Building 14 (Hayden libraries), and the demands and constraints of off-site storage management. Thanks to the generosity of an anonymous donor, work was begun on a modern preservation center—a first for the MIT Libraries.

Construction projects happily consumed a considerable amount of time and energy throughout the year. Progress toward improved library facilities for MIT students and faculty has been sorely needed and is heartily welcomed. Following last summer's investment in compact shelving in the basement of Building 14, FY2002 saw investments in a 24-hour study space for the Hayden libraries, improved security and working environments for Archives and Special Collections, improved quarters for Technology Systems staff, and the development of facilities to house the new donor-supported contemporary preservation program.

As always, library staff were the power train that moved the Libraries forward in their phenomenal progress. Although the Libraries bid fond farewell to several senior staff who moved onward and upward in their careers, truly exceptional senior staff were recruited to fill their shoes, and equally exceptional staff were retained. Internal promotions continued to recognize the wonderful talent within the Libraries' ranks. Nina Davis-Millis provided highly capable interim leadership of the Public Services directorate. James Mullins was promoted to the position of associate director for administration effective as of September 1. Mary Cabral accepted the position of assistant to the director in January. Following a nationwide search, Steven Gass was selected to become associate director for public services and promoted to that position in May 2002. After a similarly ambitious search, MacKenzie Smith joined the MIT Libraries as associate director for technology, effective January 22. MacKenzie hit the ground running, and under her leadership enthusiasm about the importance and utility of the Libraries' research agenda, and especially the DSpace project, grew by leaps and bounds

Strengthening Infrastructure and Relationships

Because the individual reports of the respective directorates detail and reflect upon progress toward strategic objectives of the Libraries during FY2002, this report will focus largely on the Libraries' efforts to strengthen the infrastructure and working relationships so critical to long-term success.

The first of these efforts was directed toward working within the Institute's larger planning activities to develop a much-needed long-range facilities plan for the MIT Libraries. In June 2001 the Libraries' senior administration began a series of meetings with the senior staff of the Institute's Planning Office to identify and discuss the viability of a variety of potential sites for a new, combined science and engineering library facility. During the fall and winter, under the auspices of the Faculty Committee on the Library System, detailed research was conducted to document the needs of the MIT Libraries and to benchmark those needs against the status of libraries among MIT's peer institutions.

With the May 2002 publication of the report of the Faculty Committee on the Library System entitled "MIT Libraries: Meeting Critical Needs for the 21st Century" (available on the web at http://libraries.mit.edu/about/news/critical-

needs.html), and the report's positive reception from faculty and administration, more detailed planning became possible. A provost-initiated program committee is expected to be formed in the near future. That committee will be charged with identifying program priorities and making recommendations for sites for a new library to combine science and engineering resources and services. Planning for the renovation of the Humanities Library is expected to follow thereafter.

A second set of efforts revolved around the importance of assuring continuous staff training and effective organizational structures. Changing technology creates demands for new library services and new ways of delivering services, and library staff members must have both the skills required to work in such new environments, and an organization that effectively supports their work.

As the MIT Libraries have gained practical experience with an information technology–intensive service environment, it has become increasingly clear that staff skills must be continuously enhanced and extended. To this end, in FY2002 the Libraries' travel policies were reviewed and revised to insure that budgeted funds are used wisely and equitably. Likewise, during the year a significant sustained effort was applied to insure that library staff are adequately trained in the use of the new library management system. Attention was also paid—and will continue to be paid—to creating an ergonomically appropriate environment for library staff.

The MIT Libraries have long been noteworthy for their ability to operate an agile organization. Perhaps because service has always been a high priority, reorganization and realignment seem to come more easily to the intelligent and dedicated staff of these libraries. The staff of the MIT Libraries are also admirably motivated to collect and utilize relevant data in their decision processes. Indeed, over the years, many of the Libraries' most constructive organizational changes have originated in the very staff groups and departments that would be most directly affected by the recommended change.

In the spirit of this tradition, a number of reviews of the Libraries' organizational and service delivery structure were undertaken in FY2002. Reviews initiated during the year included the Reference Visioning Project; a review, reconfiguration and realignment of systems and technology support; a project to rethink instruction and orientation activities; and a new approach to providing reserve reading support for the Science and Humanities Libraries. In April 2002, following a careful analysis, the Institute Archives became a department of Collections Services reporting to the associate director for collections services. The DSpace Implementation Team studied and made recommendations regarding the Libraries' necessary organizational response if we are to be successful at operating DSpace as a stable service to the MIT community.

The third group of infrastructure/relationship efforts in this fiscal year addressed the importance of partners and supporters to library initiatives. In FY2002 the Libraries' resource development activities made great strides in building effective relationships within the Institute. The proof of this achievement was manifest in the number and size of proposals being requested, and of gifts being designated to the Libraries as the year progressed. Among the more noteworthy programmatic initiatives of the year were the Honor with Books program, which broke new ground in presenting gift options to families of MIT undergraduates, and the numerous opportunities presented to the Libraries to discuss the excitement of a contemporary library with Institute development staff, alumni/ae groups, and MIT Clubs.

The DSpace project presented a substantive opportunity for the MIT Libraries to collaborate formally with the MIT Press. Over 100 MIT Press out-of-print books in digital form have been added to DSpace. By tracking usage statistics MIT Press will be able to determine the level of interest that exists for these books.

Acknowledgements

The Libraries were privileged in FY2002 to continue their participation in such important Institute activities as the Council on Educational Technology and the Information Technology Architecture Group. The DSpace team and Libraries Steering Committee deeply appreciated the continued engagement of Hewlett-Packard Company in the Libraries' research program, and greatly valued the opportunity to work closely with the exceptional Hewlett-Packard staff who came to MIT to collaborate on this partnership.

The MIT Libraries were also most grateful for the ongoing support and interest of the Andrew W. Mellon Foundation in the DSpace project, and for the enthusiasm for the DSpace project that emerged from within the leadership of Cambridge/MIT Institute. As always, Academic Computing and Information Systems were enthusiastic and capable collaborators in furtherance of the Libraries' mission and goals. For the Libraries' progress in physical planning and renovation activities, thanks go to a host of MIT staff and administrators. The Libraries' ambitious facilities improvement program would surely have sputtered and stalled without the support of the Institute's space planning, campus planning, facilities, and construction management groups.

The MIT Libraries are indebted to many groups and individuals, both inside and outside the Libraries, for a year of tremendous progress. Much has been accomplished, and there is much still to do. It is a rare privilege to work with such capable colleagues to provide library support to students and faculty of the caliber found in every discipline and department at MIT.

Finally, this report would not be complete without acknowledging the steadfastness of the MIT Libraries staff in the wake of the devastating events of September 11, 2001. Despite their personal fears and concerns, the staff of the MIT Libraries found strength in one another and in their commitment to providing a safe and sympathetic environment for the MIT community in a time of great anxiety. Thanks to the staff of the Libraries, our facilities remained open and our work went on, providing MIT students with a stable and secure space to think, study, and re-imagine normalcy. I am personally proud to work with such a caring, committed staff.

Ann J. Wolpert
Director of Libraries

More information about the MIT Libraries can be found online at http://libraries.mit.edu/.

Public Services

The MIT Libraries' Public Services staff can take great pride in its accomplishments this past year as we near the completion of the third year of the Libraries' five-year strategic plan. Under the able interim leadership of Nina Davis-Millis during the nine-month search for a new associate director, Public Services maintained strong momentum in advancing the Libraries' objectives of developing a suite of resources and services focused on providing users with the most effective and intuitive library environment possible.

The challenges of transforming the 20th century research library, primarily based on physical objects (books and journals) and physical locations, into the research library of the 21st century are enormous. On a day-to-day basis Public Services staff collaborate with the other departments of the MIT Libraries as well as departments, labs, and centers across the Institute to move us toward a seamless library environment where resources and services are available around the clock, and library spaces support the needs of our users to browse relevant collections, receive state of the art reference and instructional services, and find quiet study space that promotes scholarly reflection. The three strategic directions identified in the Libraries' strategic plan provide a useful framework for reporting on how this past year's accomplishments contributed to our progress.

Strategic Direction I—Excel at providing rapid, easy, and precise access to high quality information for education and research at MIT

The 3rd Barton implementation involved a wide variety of staff in enhancing functionality in support of user access to correct bibliographic information and improved services. The Circulation and Processing Committees and the OPAC Task Group played leadership roles in developing workflows and enhancements for our new Aleph library management system. The efforts provided by all in support of this major initiative cannot be understated.

A reference vision for the MIT Libraries was developed incorporating the input of both users and staff. Led by the Reference Committee and resulting from issues emanating from the "Ask Us Live" digital reference service pilot of the last year, a Reference Vision Task Force was formed and created an exciting vision for all of Public Services focused on three goals:

- Simplifying access to libraries' materials, services, and staff expertise
- Encouraging flexibility and experimentation for library staff and services
- Successfully marketing services, externally and internally

Geography Information Systems (GIS) services were established. Our new GIS specialist, based in Rotch Library, has done a remarkable job initiating a GIS program within the libraries. This initiative was made possible due to close collaboration with the Academic Computing Practice within Information Systems. Since arriving last July, the GIS specialist has quickly developed a physical and virtual program that provides growing support for a diverse community. Activity for this past year peaked in April when she answered over 100 reference questions and the GIS web site received over 800 hits.

eDelivery of documents to the user desktop continued to improve and grow dramatically.

Beginning in April, all interlibrary-borrowing photocopy requests by MIT faculty, students, and staff were delivered by the Interlibrary Borrowing Office's new electronic documents service, providing PDF images delivered directly to the user's desktop via the web. This has dramatically increased the timeliness of delivery, and has been received enthusiastically by the community.

Fee-based document delivery services provided by Document Services are now dominated by eDelivery with 72 percent of all journal articles and 48 percent of all theses delivered in electronic format, a growth of 31 percent and 20 percent, respectively.

A data services librarian was hired. Starting in late August at Dewey Library, she has quickly begun assessing the social science data needs of the community. Over the next year she will be developing a coordinated plan across the MIT Libraries to improve support for this critical area.

Instructional activity nearly doubled this past year. Of particular note was an initiative of the Instruction Committee to promote EndNote, a powerful bibliographic citation manager, to the community.

Outreach activity, supported by the many Public Service user groups and coordinated with all subject selectors, continued to grow. Many of the groups worked closely with the Web Advisory Group and our webmaster and usability specialist to continuously improve upon our public web site.

An orientation coordinator was hired in January. Based in the Humanities Library, she has actively begun coordinating and planning orientation activities with our user groups.

Strategic Direction II—Ensure that library spaces and operations facilitate life on campus

The Hayden basement compact shelving project was completed resulting in:

- More efficient use of basement stacks for both the Humanities and Science Libraries
- Access to more years of highly used journals
- Better organization of the humanities and science bound journal collections
- Faster turnaround time for the reshelving of all journals
- Preservation and storage of fragile materials
- Reorganization of current periodicals and books in the Science Library, including the removal of tall index stacks in the middle of the reading room, resulting in a more open and visually attractive space.
- Improved signage throughout Hayden Library

Planning continued for a renovated Hayden entry, service desk, and 24-hour study room, with construction beginning in May and continuing over the summer.

Planning continued for a new, combined Engineering and Science Library along with a fully renovated Hayden Library in support of the humanities and certain social science areas. The Faculty Committee on the Library System issued a detailed report, "MIT Libraries: Meeting Critical Needs for the 21st Century," which received strong support from the Faculty Policy Committee and Academic Council.

Detailed planning began for a new Dewey Library within the overall East Campus Building Project.

Planning continued for the Libraries' Information Kiosk that will be located on the Student Street of the Stata Center. Projected to open in early 2004, the kiosk will accommodate quick information access, individual and group instruction, and promote library resources and services for the community.

Many units made significant improvements to their existing facilities to better support student learning and research:

- Barker purchased new study chairs for all of its study carrels on the 6th, 7th, and 8th floors.
- Dewey purchased 35 new chairs for study and increased its electrical capacity to better support user needs.
- The Humanities Library created an improved newspaper and periodical reading area.
- Rotch incorporated a new GIS Laboratory into its space to support our burgeoning GIS program. This was facilitated by generous funding for equipment by the Academic Computing Practice within Information Systems.
- As stated above, the Science Library took advantage of the Hayden basement compact shelving project to improve both the aesthetics and functionality of its reading room.

The establishment and hiring of a circulation supervisor within Hayden Library Access Services has resulted in improved management of circulation and stacking services for the Humanities and Science Libraries. Users of Hayden have a much easier time finding materials on the shelf or tracking items when off the shelf. This position was created through the internal reallocation of funds.

Strategic Direction III—Be a leader among academic research institutions in the use of applied library technology

The Libraries continued its pilot "Ask Us Live" digital reference service, expanding the hours during spring semester until 7 pm, Monday through Thursday. This exciting and challenging project attempts to provide virtual real-time reference help via the web, allowing both user and staff to share each other's virtual information environment. To better manage this initiative, a digital reference coordinator position was established in the Humanities Library by internal staff reallocation.

Staff were involved in the "early adopter" phase of the DSpace project, helping the DSpace developers design highly usable interfaces and working with the community to publicize and educate.

Staff contributed to the Libraries' Enhanced Navigation Project in an effort to improve users ability to quickly navigate through our many electronic resources and connect to the information most relevant to their needs.

As mentioned earlier, many have been involved in the ongoing implementation of the Aleph library management system to enhance its ability to help our users access a wide variety of information, ranging from bibliographic citations to lists of items they have checked out from the MIT Libraries.

Our Most Precious Resource

The long list of accomplishments this past year is due to the extraordinary talents and motivation of our staff. The willingness of Public Services to continuously examine its operations, take advantage of technology, and redefine positions and programs as necessary is a critical component of our ongoing success. Above all, however, is the steadfast commitment of staff to provide the best possible services for our faculty, students, and staff. Of particular note are those Public Services staff members selected to be recipients of the Libraries' Infinite Mile Award this past year:

- Margaret Bloom in the category of Results, Outcome, and Productivity—Maggie was recognized for the excellent improvements she has brought to stacking in Hayden Library, resulting in better access to materials for users.
- Mike Cook and Neal Johnson in the category of Results, Outcome, and Productivity—Mike and Neal oversaw the conversion of more than 75,000 pages of publications from the Laboratory for Information Decisions and Systems in PDF format along with OCR for inclusion into DSpace while continuing to manage their regular assignments.
- Eileen Dorschner in the category of Innovation and Creativity—Eileen was recognized for extraordinary creativity and steadfast leadership during the renovation of the Aero/Astro Library in 2000–2001.
- Carol Frederick in the category of Community—Carol was recognized for the extraordinary service she provides for the users of Barker Library and the close personal connections she has made with so many students.
- Tracy Gabridge in the category of Results, Outcome, and Productivity—Tracy was recognized for her extraordinary contributions to the 3rd Barton OPAC Task.

Priorities for the Future

The MIT Libraries remain steadfast in its mission:

> The MIT Libraries are creative partners in the research and learning process. We select, organize, present, and preserve information resources relevant to education and research at MIT. We sustain these world-class resources and provide quality services on behalf of the present and future research and scholarly community. We build intellectual connections among these resources and educate the MIT community in the effective use of information. We want to be the place people in the MIT community think of first when they need information.

If we are to be "the place people in the MIT community think of first when they need information," we will need to evolve our organization, resources, and services to meet the needs of our dynamic users. The reference vision developed by Public Services this past year provides an ambitious framework for doing just that. The vision imagines:

- A reference environment that enables user self-sufficiency and easy access to information staff
- Library space, both physical and virtual, that is intuitive
- An environment that facilitates independent discovery and provides quick connectivity to appropriate experts when needed
- The availability of real-time assistance extended to better meet community needs
- All staff well trained in customer service, library policies and procedures, and a core set of information tools and resources
- A robust referral system that provides the timely linkage of users to subject and technical experts, and ensures necessary follow-up and assessment

Working toward this vision in a manner that is flexible and sustainable is an important priority and challenge for Public Services. To do so will require an increased focus on training, developing useful metrics for assessment, and a sophisticated understanding of how technology can best support our efforts.

Statistics demonstrate the importance of evolving our service model to best serve the user community. The continued expansion of resource and service delivery to the user's desktop has contributed to what appears to be a slow but steady drop in user visits to our physical locations. This year's door count was down 11.5 percent across the five divisional libraries. While activity at reference desks also continued its downward trend, libraries that experimented with capturing statistics on reference activity away from the reference desk showed increases in total reference activity, anywhere from a modest 4.4 percent to a dramatic 43 percent. Beginning this year all of the divisional libraries will capture reference statistics both at and away from the reference desk in a consistent manner so we can better assess how to improve our service model. Instructional activity increased significantly with 244 sessions offered (71 percent increase) and 5,714 attendees (95 percent increase). Because our new Aleph library management system counts some circulation transactions differently than the previous system and other 3rd Barton implementation issues were a higher priority during the past year, it is impossible to do a meaningful comparison of circulation activity between this year and last. Interlibrary borrowing activity remained steady (a decrease of 1 percent), with 12, 977 requests made and 96 percent of them fulfilled successfully.

Other important priorities for the coming year will be the smooth rollout of the new Hayden Entry Project that will create a new service model in Hayden by integrating three units which previously were separate (Circulation, Reserves, and Interlibrary Borrowing) and provide a much desired 7x24 study room for students. Additional planning will continue for the longer term space needs of the libraries, including a combined Engineering and Science Library, a renovated Humanities Library, and a new Dewey Library within the East Campus Building Project. Long term space planning remains an important priority due to the existing reality of "steady-state" collections. This requires Public Service units across the system to work closely with staff in the RetroSpective Collection and other units within Collection Services, spending huge amounts of time identifying and processing materials for off-site storage. Work will also continue in improving 3rd Barton, taking advantage of enhanced navigational tools like SFX, and improving the usability and functionality of our web based resources and services.

No report of this nature can do justice to the extraordinary number and variety of accomplishments seen this past year in Public Services. To do so would require reading the annual reports of all the divisional and branch libraries, functional committees, user groups, and programs which make up Public Services in the MIT Libraries. As the newly appointed associate director for public services it is my pleasure and privilege to work with such a great staff for the common goal of providing the best possible library services in support of the MIT community, now and in the future.

Steve Gass
Associate Director for Public Services

Collection Services

This was once again a year of tremendous achievement in Collection Services, in spite of major obstacles.

Building Collections of Distinction and Relevance

Several opportunities enabled very significant progress in building collections that will enable the work of MIT's students and faculty (present and future).

Support for New Programs

Provost Brown granted the Libraries $100,000 in the FY2002 budget to purchase information resources in support of new programs at the Institute. This funding provides essential support for new curricular areas, new faculty with new research interests, and the continually emerging new programs that distinguish MIT. The funds were targeted toward new areas with clear collections gaps:

- Comparative media studies—purchased monographs with an international perspective mirroring the global focus of the program. Also a concentration on the cultural impact of new information technologies and analyses of cybersociety. Also eight new journal titles in communication theory and media studies.
- Film studies—initiated the development of research level collections, in support of the Comparative Media Studies program, as well as 27 courses across the arts and humanities that currently include film studies.
- Life sciences—purchased approximately 50 new online biomedical journals, including *Cell Press*, *Nature Reviews*, American Society of Microbiology, and American Physiological Society journals. Also a collection of electronic medical textbooks, including such classics as Harrison's *Principles of Internal Medicine* and Stedman's *Medical Dictionary*. Also online reference works such as StatRef, a database of full-text medical books and dictionaries, Nature Publishing's *Cancer Handbook*, and four of the *Current Protocols* full-text series.
- Bioengineering and environmental health—purchased 24 new journals (paper or electronic) in cell and tissue engineering, five new journals and two electronic reference works in pharmacology and toxicology, five new journals and an expansion of the American Chemical Society journal package in the areas of genomics, proteomics, glycomics, and bioinformatics, and four new journals in therapeutics and materials research. Also established a new monograph fund to support the needs of the Biological Engineering (BE) Division. In the first year's expenditures the emphasis was on biomaterials; metabolism of drugs and toxins; molecular, cell and tissue biomechanics; and cell and tissue engineering.
- Earth sciences—established monograph funds in support of the Professional Master's Program in Geosystems and the geobiology interests of new faculty. Purchased 24 monographs in geosystems and 16 monographs in geobiology in the first year.
- Human rights—in support of the Program on Human Rights and Justice and the Center for International Studies, purchased monographs and major journals in the area of human rights with a special emphasis on international law.
- Biotech industry—in support of a still-growing area of research in the Sloan School, purchased critical tools for in-depth industry analysis, both electronic and print, such as *Recombinant Capital* database, *Scrip Pharmaceutical Companies Fact File*, *Drug and Market Development Newsletter*, *BioWorld Genomics Review*, and *GEN Database of Biotechnology Companies and Resources*.
- E-Commerce—significantly improved electronic access to data and market research with the Yankee Group database among others.

Gift Funds

- Howard Hughes Medical Institute funds—purchased 11 years of backfiles of *BIOSIS*, making the full database back to 1969 now available. Also 42 new textbooks from the Brandon-Hill medical school core list. Also Nature Publishing's *Encyclopedia of the Life Sciences.*
- Environment—Professor Rosenblith designated the use of $50,000 from the Alice C. Tyler trust for library materials related to the environment. The expenditures are being spread out over two years. Many monographs were purchased this year, but we will report more fully next year.

Digital Resources Funds

Again in the FY2002 budget, Provost Brown provided $125,000 for the purchase of new digital resources. This funding was provided on a one-time basis. Because all the products purchased require continuing funding, the Libraries will seek to "harden" these funds in FY2003. Major purchases included the following:

- Engineering and science: Nature Monthlies and Review journals; Knovel (engineering and scientific handbooks online); Safari Technical Books (O'Reilly imprints); Environmental Science and Pollution Management database; Gmelin Crossfire (inorganic chemistry); Wiley Interscience electronic journals; ChemNetBase Combined Chemical Dictionary
- Social sciences and humanities: *New York Times* historical archive; Early English Books Online (supplementing significant funding from the dean of humanities, arts, and social sciences); JSTOR Arts&Sciences II collection; JSTOR Business collection; Sanborn Digital Maps for Massachusetts; ERIC documents in fulltext; Roper Public Opinion Research membership, including 50 studies per year; Bibliography of Asian Studies; STAT-USA Internet (business, economic and trade information); CSA Worldwide Political Science database; Information Science Abstracts

General Institute Funds

As usual, the Libraries purchased approximately 20,000 new monographs and maintained approximately 11,000 serial subscriptions (including paper and electronic journals and databases) from annual recurring funding, with an inflation increment. Inflation in journal prices was just under 7 percent.

Government Documents

The Libraries acquired over 6,000 government documents items, representing about 52 percent of all titles distributed through the Federal Depository Library Program.

Gifts in Kind

The Libraries added nearly 2,500 books donated primarily by MIT offices and faculty. Donors of major gifts are Ann Chase Allen (monographs in engineering, sciences, and linguistics), Anthony E. Alonzo (a limited edition of Dante's *La Divina Commedia*), Lois Craig (scores and CDs of 20th century violin and other music), estate of Peter Elias (monographs in electrical engineering and computer science), Arthur W. Rice III (*The Executed Works of Parker, Thomas, and Rice*), and Thomas C. Wilder (*Skillings Mining Review*).

Archives and Manuscripts Additions

The final installment of the Planning Office records was transferred in September 2001. These records constitute the largest collection of administrative records acquired to date. The following new manuscript collections were received: the papers of physicist Felix Villars, materials scientist Nicholas J. Grant, consulting engineer Peter Glaser, LIDS professor John E. Ward, and a small collection of papers of Lydia G. Weld, the first woman to receive a degree in naval architecture from MIT. Also received were significant additions to the papers from the family of linguist Kenneth Hale and from the family of mathematician Dirk Struik. Perhaps the most compelling records the archives acquired this year were the two banners placed in Lobby 10 to capture the written thoughts and feelings of the entire MIT community after the September 11 terrorist attack. A box of memorial objects left with the banners has also been preserved. Shirley Jackson was honored at a Corporation luncheon on December 7, and officially thanked for her gift of the papers from her tenure as director of the Nuclear Regulatory Commission.

Enabling Effective Access to Collections

Delayed implementation of several features of our new library management system, Ex Libris's Aleph system, impeded Collection Services' ability to provide timely access to new collections. At the same time, other initiatives expanded our options for enhancing access.

3rd Barton

Last year's annual report chronicled the significant efforts related to planning the implementation of a new library management system. The public functions of the new system were implemented on July 9, 2002. Unfortunately, a few major obstacles significantly delayed the implementation of the processing functions.

One of these obstacles was the failure of Ex Libris to deliver a loader for incorporating records from our major supplier of catalog records. This record loader was not installed until late November, resulting in a five-month delay in loading catalog records for new materials. By December there were in excess of 8,000 volumes in the

workspace awaiting final processing. In valiant efforts to catch-up, some staff worked extra hours, others volunteered to work across departments, and temporary staff was hired. However, there was still a significant arrearage at the end of the year.

Another obstacle was the unanticipated delay and miscommunication surrounding our need for a test server for many functions, including testing the loading of authority records and records from other vendors. This server was not purchased and installed until late spring. That enabled staff to finally test authority record loading, loading of records from miscellaneous vendors, and year-end closing processes (nerve-rackingly close to year-end!).

A third major obstacle was the limitation of the system for report generation. Some of these "reports" are basic outputs needed for our business practices, like purchase orders. The information technology librarian, the systems manager, and many other staff worked diligently to analyze and develop uses of the canned reports. A significant breakthrough was realized when we engaged the IS Data Warehouse staff in a collaboration whereby our data is loaded into the Data Warehouse and reports can be generated with the BrioQuery software. (The process of setting up all of the various reports we wish to utilize is still continuing.) Due to these delays in report writing, as well as to problems with the fund accounting system, our acquisitions processes could not be fully implemented until October. It is a credit to the acquisitions staff that they were able to order and receive orders for the entire year's expenditures in the remaining eight-month period, even in a year when we had additional funding as described above.

We are working hard (and smart) to return in the next year to a steady-state processing environment without delays that impede access to our rich collections. We are confident the new system will become a useful tool, instead of a major hurdle, when staff have the time to explore and utilize all of its features.

Enhanced Navigation Implementation Group

One of the Library Council strategic initiatives for the year was to plan the implementation of ExLibris' SFX and Metalib applications to provide enhanced navigation of information resources. A system-wide group, co-chaired by the head of Serials and Acquisitions Services and the information technology librarian, was formed to explore the potential of these tools. Some of the group members presented a demonstration at the all-staff meeting on June 26. There are very interesting possibilities for significantly enhancing access to information resources by cross-searching between various databases and by linking between resources. The group's report is due in July, and after it is received decisions will be made about implementation in FY2003.

Metadata Advisory Group

A second group, chaired by the head of Bibliographic Access Services, was charged with developing metadata expertise, coordinating metadata applications within the libraries, and providing advice and guidance related to metadata for digital projects at MIT. Collectively they upgraded their knowledge of several metadata schema. Several group members contributed to adapting the Library Application Profile of Dublin Core to a descriptive metadata schema for Dspace, and to the creation of a MARC to Dublin Core crosswalk. One of the group members became part of a two-member team carrying out a three-month study to advise the Open CourseWare Project on its metadata needs.

These efforts, as well as those related to SFX and Metalib, significantly expand the skill-base and "reach" of Collection Services librarians.

Barton Records

In spite of the difficulties encountered in normal processes, staff were diligent in their efforts to provide access to newly acquired materials in all formats, as well as enhanced access for existing collections in Barton.

In spite of the loss of system capacity for five months, monograph cataloging productivity for the year was at levels similar to the last three years. MIT publications staff initiated a process whereby we insert abstracts into records for MIT theses, vastly improving keyword access. Database Maintenance carried out several projects to clean up Barton data that was corrupted during the migration to Aleph. The copy-based cataloging section worked as a team with original catalogers to carry out cataloging of the conferences in the IEEExplore database, a cooperative project with the Catalog Department at the University of California, San Diego. In original cataloging, all titles in the gifts backlog were cataloged during system downtime. The rare books cataloging project completed the first full year of production. In special formats cataloging, steady progress was made on CD-Rom, video and electronic database cataloging. Maps cataloging has slowed somewhat due to other projects. In music cataloging, with the searching assistance of acquisitions staff during down-time, work began on cataloging scores from the collection of the late MIT professor John Corley. Work also began on cataloging sound recordings recently acquired from the MIT Museum.

Serials cataloging created 755 catalog records for e-serials and e-journals. They also completed a project, begun in 1998, to create online catalog records for all of the unclassified periodicals represented in the card catalog. In addition, the work to create online catalog records for the serial collections in the RSC continued, with a focus now on the 500s and 600s of the Dewey Decimal collection, and on journals being moved to the Harvard Depository.

RSC staff continued the multi-year project scanning DDC monograph title pages for cataloging by OCLC; an additional 12,000 records were created this year.

A cross-unit (serials cataloging, database maintenance, systems, and special formats) effort resulted in planning and readiness for utilizing OCLC set records for the Kluwer journals package. These records should be loaded early in the new year.

So while backlogs exist, catalog access continues to increase in breadth and depth.

Vera Records

The Libraries continue to provide two access tools for digital resources, Barton (the online catalog of the Libraries' collections) and Vera (the web-based listing of e-journals and databases). Digital Resources Unit staff, with assistance from serials acquisitions staff, added 1,356 records for e-journals (a 41 percent increase) and 96 records for databases (a 35 percent increase) to Vera.

Access to Archives Collections

In February the Institute Archives reduced public service hours in order to initiate an intensive processing project to organize important administrative and research material related to MIT's history. By year-end the staff had completed the arrangement and description of the Planning Office records, in addition to working on several smaller collections. The project will continue until February 2003.

Two special processing projects were carried out with the support of grants. Dr. Peter Glaser provided funds to process his papers, the bulk of which relate to his work concerning the solar power satellite. The American Institute of Physics awarded the archives a grant to process the papers of physicist Victor Weisskopf.

Other significant efforts this year were revisions to the Institute Archives' public web site and a new service "Ask the Archives," by which means the staff provides immediate response to researchers requesting information online. The department continued its ongoing exhibit of an "Object of the Month," with a specific goal of making the rich diversity of the archives' holdings more apparent.

Once again, undergraduate and graduate students in a course taught by Professor David Mindell made intensive use of the collections. These group projects resulted in public presentations of the research in early December.

Manuscript collections with substantial use this year were the papers of mathematician Norbert Weiner, engineer Harold Edgerton, historian and philosopher of science Thomas Kuhn, MIT president Jerome Weisner, and the Rotch Traveling Scholarship. As always, presidential and Corporation records were in use frequently, as well as those of the Social Action Coordinating Committee and the Albert Farwell Bemis Foundation.

Finally, a renovation of the Institute Archives' space provided significant improvements to conditions for using the collections, as well as for staff functions. This space change was precipitated by the need to vacate storage space in the basement in order to accommodate the expansion of Preservation Services space. The archives staff worked with the Libraries' administrative staff, MIT project managers, and the architectural firm of Hallor and Associates to plan the renovation. Construction took place between December 2001 and March 2002.

Managing Collections

Government Documents

Our serials acquisitions librarian, with assistance from many staff throughout the Libraries, carried out an extensive self-study of our depository government documents processes and services, as required by the Federal Depository Library Program (FDLP). This work also prompted staff to develop a government documents collection development policy and a government information web page. In addition, a government documents procedures manual is now available on the staff web site. The Dewey Library, the Humanities Library, and the Science Library completed reviews of the superintendent of documents classes and items, resulting in a significant number of de-selection decisions and the discovery of many items (especially electronic versions) requiring cataloging.

Collections Space

The project to install compact shelving in the Hayden basement was completed in October 2001, adding approximately 8,000 linear feet of shelving, with the capacity to house about 48,000 journal volumes. In addition to the shelving installation, the entire basement and much of the science collection on the first floor were shifted into a more logical arrangement. Shelving for unbound journal issues was purchased for the first floor. All bound volumes are now integrated in the basement shelving. All of the shelves and volumes were also cleaned.

Storage

Storage activity was slower-paced than in previous years, due in part to the new capacity in the Science Library and also to the processing issues related to the Aleph implementation. Nevertheless, 36,000 volumes were moved to Harvard Depository and 14,000 were added to the RetroSpective Collection in Building N57.

Two changes were implemented regarding user access to stored collections in the RetroSpective Collection. The stacks were closed to browsing for safety and security reasons, and a policy was implemented requiring people without MIT identification to schedule on-site visits one business day in advance. Planning to deliver articles electronically continued. The technology involves image

capture on a Minolta planetary scanner and delivery of files to the users via the web using the Prospero software incorporated into the Ariel 3.01 software. A test phase with Document Services as the "customer" was initiated in May, with a full fee-based service anticipated for the fall semester.

Preservation

Preservation Services staff continued their usual attention to caring for the Libraries' collections in a number of ways—commercial bindery preparation and management, in-house repair treatments, responding to various building leaks, and a condition survey of rare books in tandem with the rare books cataloging project. However, the excitement in Preservation Services was generated by planning for new space and an expanded program. A combination of donor funding and CRSP support enabled planning for a new laboratory. The planning was assisted by Nancy Carlson Schrock, preservation consultant, and Michael Hallor, architect. Construction began on May 28, with an estimated completion date of late August.

A new donor-funded position, conservator, was posted in the late spring, with the expectation of filling it by the time the new laboratory is ready for use. Dedicated to conservation of rare and unique materials, this position will enable the Libraries to address the deterioration of some of the remarkable items in its collections, and, in some cases, to perform digital scanning so that researchers may have access via the web.

Records Management

The expertise and perspective of Institute Archives staff were requested in relation to two Institute initiatives this year.

The Financial Data Retention Project, sponsored by the Institute auditor, the director of libraries, and the associate controller of CAO, investigated the need for a team to review the challenges of financial records which are increasingly in electronic form. The head and associate head of the Institute Archives were members of the Financial Data Retention Team.

The second project was initiated by the newly reconfigured Environmental, Health, and Safety Office, which is seeking assistance in designing an electronic information delivery system. The associate head is advising the EHS staff members who are managing the project, with the proposed assistance of an outside records management consultant.

Changing Organizational Structure

Institute Archives and Special Collections

When a vacancy occurred in the position of associate director for public services in August, the reporting line for the Institute Archives and Special Collections was transferred to the associate director for collection services on an interim basis. In May, the head of the Institute Archives announced her resignation, effective June 7. After consultation, the director of libraries announced that the Institute Archives would report within Collection Services on a permanent basis. This restructuring will provide better coordination of efforts related to all of the Libraries' collections. The position of head of the Institute Archives was posted in June.

Digital Resources Acquisitions

Once again this year, it became apparent that we had insufficient staff assigned to supporting the acquisition of digital resources. Several years ago we created the position of digital resources acquisitions librarian, and more recently we dedicated a part-time support staff position, digital resources acquisitions assistant. This year, instead of transferring a single additional position, we restructured in a way that we hope will enable us to respond more flexibly in the future. The digital resources acquisitions librarian will continue to be responsible for managing orders for databases and packages, for negotiating licenses when a standard license does not suffice, for serving as the licensing and compliance expert for the Libraries, for chairing NERD (the group that selects digital products purchased from central funds), and for coordinating DigProb (the group that responds to user problems with digital resources).

Other tasks, along with the position of digital resources acquisitions assistant, were reassigned to the serials acquisitions section. The head of that section is responsible for all of the financial transactions and records, and for managing the use of the standard license and standard interfaces. The section staff will be responsible for managing orders for individual e-journals. As time goes by, we anticipate a continuing gradual transition of staff effort from the acquisition of print resources to the acquisition of digital resources.

Recognizing Staff

One Collection Services staff member and one Collection Services staff group were recognized with the Libraries' Infinite Mile Awards:

- Ellen Duranceau, the digital resources acquisitions librarian, was honored in the category of Communication and Collaboration.
- The Monograph Acquisitions Section (Debbie Fazio, Charlene Follett, Bruce Goodchild, Betsy Granese, Whit Hill, Laura Lucero, and Garry Ziegler) was honored in the category of Results, Outcome, and Productivity.

During April-May 2002, we hosted a Fulbright scholar, Cecile Pierre, from the Bibliotheque Interuniversitaire Scientifique Jussieu in Paris. Her research project related to the management of digital information resources in libraries in US universities. She worked directly with the

digital resources acquisitions librarian, attending meetings and contributing to discussions. She also visited five other libraries in New England. Cecile challenged our assumptions and forced us to articulate our beliefs and goals. It was a pleasure, as well as an honor, to host her.

Carol Fleishauer
Associate Director for Collection Services

Administrative Services

Administrative Services (AS) supports the MIT Libraries' mission and goals in the areas of budget analysis and planning, delivery services, facilities-planning/operations, financial, payroll and staff records, personnel, and procurement. The services provided by AS are fundamental to the operation of the libraries—recognizing its role in providing the infrastructure necessary to support library staff in their provision of services and resources to library users and their responsibilities to the Institute. The goal of AS is to work behind the scenes in concert with library staff and with departments throughout the Institute to insure that staff are recruited, hired, retained, remunerated, and provided growth opportunities consistent with MIT policies in well-planned and maintained facilities, at present and in the future, and that all funding is accounted for and fairly distributed within the libraries.

The associate director for administration and the AS staff in collaboration with the director and the other associate directors have worked to define and refine the role for AS, especially in its expanded role to plan for facility renovation and expansion. The involvement in this area will continue to grow as the Libraries explore the physical needs necessary to provide services and to house resources in the 21st century.

Budget and Financial

The Libraries' new integrated computer system, Aleph, went online in July 2002. Preparatory and subsequent to the implementation, the financial administrator collaborated with colleagues in Serials And Acquisitions Services to test the transfer of financial data from the previous system to the new. In addition, several training sessions were given by the financial administrator to instruct staff on the ins and outs of accessing financial data. For the first time, the Data Warehouse was utilized to draw information from our internal systems, compile reports, and support analysis of budget trends over a period of years. The processing of invoices for payment is being sent electronically to the CAO, which has proven to be an efficient process for the Libraries and CAO. Further efficiencies and reduction of costs have been realized by expanding the use of the VIP Card throughout the Libraries.

During FY2002 a complete revamping of the internal budget process of the Libraries was accomplished. This included new spreadsheets that enabled better expense and budget projections with links between accounts that would reflect changes from one allocation to another. The Materials Budget Council (MBC) was formed to facilitate communication and streamline payment and accounting of library material expenditures between Serials and Acquisitions Services, Collection Management Services, and Administrative Services.

Delivery Services

The year presented challenges to Delivery Services from the significant amount of construction on campus hampering the distribution of items, to the threat of terrorist attacks by way of mailed devices, to the anthrax scare. Staff took the necessary precautions to protect themselves and their colleagues within the libraries. Moving materials throughout the libraries while distributing mail and other delivery services requires not only coordination and cooperation; it requires strong backs. The number of items moved throughout the libraries has steadily increased. Shifting an ever-increasing number of the Libraries' holdings into storage, either at the RSC or the Harvard Depository, has significantly increased the requests for and return of materials from these locations, placing additional demands upon Delivery Services.

Facilities and Operations

FY2002 saw significant steps taken on several critical facility issues, including short-term maintenance, building renovation and upgrades, and major efforts to identify long-term facility needs. In January 2002 AS was pleased to welcome the new facilities and operations administrator. The administrator has had significant experience working within the Institute's Department of Facilities, thereby providing the Libraries a better understanding of and communication with this department.

During the year, the Libraries agreed to pilot an ergonomics study in collaboration with the Environmental Health and Safety Department. The Libraries were selected due to the breadth of issues encountered within it—from the need to move and lift heavy items, to reaching and stretching, to the extraordinary percentage of staff time spent using a computer. The review began during the summer of 2002, and will be completed during 2003. At the conclusion of the project, it is anticipated that the Libraries will have identified needed modifications in the work environment as well as having established a plan to remedy the identified needs.

Early fall of 2002 saw the completion of the compact shelving project in the Hayden Library basement. This project enabled the collections to have space to grow for approximately five years, while providing the opportunity to shift collections into a more logical order. AS also supported the re-shelving and reorganization of the Science Library, including the installation of new periodical shelving. At the same time an ADA compliant workstation

was installed in the Science Library to make the Hayden Libraries accessible to all patrons.

Unfortunately, this year saw an increase in thefts of computers—from staff and patrons. Security steps were initiated within several of the libraries including more signage informing library users to monitor their belongings, and the installation of more secure devices at fire exits.

The need to prepare for an emergency was also addressed this year. At the request of the Risk Management Department, the libraries determined the value of all collections and equipment throughout the MIT Libraries—no easy task. It was accomplished through collaboration of Collection Services and Administrative Services. Although it was time consuming, the results have been informative to Risk Management and the libraries. The value of the collections, either to replace or restore, was much higher than previously calculated. This study coincided with developing an emergency preparedness plan and the start on a "disaster recovery plan" for the Libraries.

CRSP FY2002 Projects

The MIT Libraries were given an anonymous gift to support the creation of a preservation center that will house a rare book conservation laboratory. The gift was to purchase the necessary equipment and cover some staff costs. In order to house the additional equipment and staff necessary for such a center, the Libraries identified space adjacent to Preservation Services. The concurrent impact required a juggling of space between preservation, the Library Systems Office, and Institute Archives. The first step in this renovation began in January 2002 in the archives reading room and staff areas. Although inconvenient to users and staff (who accepted the hardships with stoicism), the renovation was completed by mid-March. The result was an enhanced space for researchers to access important Institute archival materials, while providing attractive and functional spaces for staff. An additional need addressed was improved security. In May 2002 Preservation Services and the Systems Office were relocated for the summer. Renovation started on the preservation center and offices for the systems staff and will be completed in August 2002.

A second project, also funded as part of the FY2002 CRSP projects, was the renovation of Hayden Library entrance to create a twenty-four-hour study space and to integrate reserves and interlibrary borrowing into an area behind the Hayden circulation desk. An enhanced science reference and computer cluster will also result from this renovation. The 24x7 study room will be immediately inside the entrance to Hayden Library. This space will provide a mix of table, soft seating, and group study rooms. This renovation will be completed in August 2002. The creation of this facility is the first step by the Libraries to meet the needs voiced by students for comfortable, safe and attractive spaces to study, whenever the need arises.

Finally, two smaller changes resulted from the above renovations. The map collection was relocated to a better space formerly occupied by the Libraries' training facility. The training facility will be incorporated into the Digital Instruction Resource Center (DIRC) to be located in the former reserve book room.

Long-Term Facility Planning

During FY2002, the effort continued to assess the long-term facility needs of the MIT Libraries. Since the MIT Libraries are housed in facilities that have had, for the most part, the same footprint since the 1960s, the ability of the libraries to house collections and provide services consistent with the demands and expectations of students and faculty of a world-renowned research institution is seriously compromised.

Several significant steps were taken during FY2002 to plan for long-term facility needs. In particular were a study undertaken by the Faculty Committee on the Library System (FCLS) and its report, "MIT Libraries: Meeting Critical Needs for the 21st Century," issued May 1, 2002. This report culminated from the study undertaken during the year to examine the needs of the Libraries' collections, services, preservation, access, study space, and staff space. The unanimous recommendation of the FCLS is that the best solution to address the needs of the MIT community is to build a new combined Science and Engineering Library, at an estimated cost of $100M–$120M for 250,000–300,000 sq. ft. and to renovate the Hayden Library to an integrated Humanities and Social Science Library at a cost of $50M. This recommendation was supported and endorsed by the Undergraduate Association, the Graduate Student Council, the Library Visiting Committee, and the Faculty Policy Committee. The administration agreed to support a planning study to evaluate options, sites, and costs and to identify donors and other funding sources to make this recommendation a reality.

Consistent with the recommendation discussed above, two other studies were begun or completed during FY2002—HASS Committee on the Humanities Library and the Program Plan for the Dewey Library. For discussion of the HASS Report see the Humanities Library FY2001 annual report. Program planning for the Dewey Library is described in the Dewey Library FY2002 annual report.

Procurement

Procurement of library supplies and equipment, and the monitoring of all contracts with vendors are completed by the facilities and operations administrator. With the appointment of the administrator in January there was a redistribution of duties among staff within AS. Major equipment purchases and contractual arrangements remained with the administrator, while the purchase of supplies and monitoring of departmental expenditures moved to the administrative assistant. This arrangement

provides for all accounts receivable and payable being centralized under the supervision of the financial administrator. Assessments are currently underway to determine the cost benefit of maintenance contracts versus "as needed" service calls for much of the Libraries' equipment.

Personnel

Recruitment

The Libraries filled 13 librarian and other administrative staff positions as a result of serious searches during FY2002. Among the vacancies filled were two associate director positions, the entry-level, librarian I position of data services librarian, a facilities and operations administrator, and the newly created position of assistant to the director. Searches that were initiated this year that have not yet been completed are those for the head of the engineering and science libraries and the head of Institute Archives and Special Collections.

The number of support staff positions filled this year was 16—half the number filled last year. Two of these positions were clerical positions and the others were library assistant positions. Of our 14 recent library assistant hires, eight of them are currently enrolled or plan to enroll in library school. MIT is an attractive environment for library school students, both for the opportunities for stimulating, meaningful work in an academic library setting, and for the tuition assistance benefit that provides many of these individuals, whose financial situations may otherwise preclude them from pursuing a master's degree, to do so. These factors have enabled the MIT Libraries to be a successful competitor in the local job market. However, salary requirements for many of these incoming library assistants have created internal equity issues, which will require serious analysis and attention over the next year.

The recruitment of student assistants in the libraries remains a challenge. There are many other jobs on and off campus that offer better wages and more meaningful career opportunities for students. In order for many library departments to carry out routine, basic services, historically performed by student workers, it has become necessary to hire temporary hourly/casual employees. While this strategy has proven effective in some cases, the legal time restrictions on this type of employment often creates hardships for departments that have invested valuable training time with these employees.

Affirmative Action

With the appointment of an Asian/Pacific Islander to a supervisory position in the Rotch Library, the Libraries increased its minority representation among the administrative staff to five percent. Of the thirteen searches conducted this year, a total of four minority candidates were interviewed, resulting in one minority hire. Despite diligent recruitment efforts in the serious search process we have been able to identify only a very few minority applicants in our candidate pools. Each applicant pool is carefully reviewed to identify any possible minority applicants, and to interview those applicants who meet the qualifications.

Minority representation among the support staff remains higher than administrative staff at 12 percent. It is interesting to note that three of the Libraries' Infinite Mile Award recipients this year are among these underrepresented minorities.

Retention

The Libraries recorded a total of 18 terminations this year—five from the administrative staff and 13 from the support staff. Of the five departing administrative staff members, one went out on long-term disability, the others pursued promotional or educational opportunities. Of the 13 departing support staff members, two received long-term disability, and the majority of the others cited reasons such as job opportunities in other fields of interest, family relocation, and commuting issues. Three support staff, freshly equipped with library science degrees, obtained professional librarian positions at local universities.

Efforts of the MIT administration on behalf of the Libraries to improve librarian and other administrative staff salaries, including the recent market adjustment received in November 2001, continue to improve not only our competitive position among peers but staff morale. According to the Association of Research Libraries' (ARL) recent salary survey (reporting 2000–2001 data), MIT ranked 18 of 112 in average professional salary, up from 23 last year. Among our true peer institutions (22) in this group, the MIT Libraries have risen in the standings from 12 to 9. It is worth noting as well that last year seven of the peer institutions outranking MIT were located in the northeast; this year only four listed average salaries higher than MIT's.

MIT dropped from a 15 ranking last year to 17 in ARL beginning professional salary. Two points worthy of note relative to this drop are: other institutions within our peer group realized a drop as well, which strengthened MIT's standing—up from 8 last year to 6 this year; and the ARL salary report is based on data submitted in August 2001 which does not reflect the impact of the market adjustment applied to librarian salaries in November 2001. (This latter point applies to average professional salary figures discussed in the previous paragraph as well.) Applying the November market adjustment as well as the FY2003 base allocation to beginning professional salaries, MIT will report a figure of $41,500 this year which represents an increase of approximately 9.25 percent.

Library administrative staff were also beneficiaries of the Institute's focus on improving IT salaries. This year's market survey of IT positions conducted by the

Compensation Office again revealed a clear need to address salaries for IT positions within the Libraries, which represent tremendous recruitment challenges for us. Data provided by HR during this process indicated most library IT salaries to be below the market minimum, some as much as 32 percent, which would have required $65,000 to bring all staff up to the market minimum. The special allocation of $13,000 provided by HR, was a first step in addressing these salary issues.

Librarian Promotions

In FY2002 the Libraries promoted four librarians in accordance with the established promotion policy for this career track. In February, a librarian I, after attaining the goals set forth in her promotion plan, was promoted to librarian II. In September, the libraries put in place a revised promotion policy for advancement from librarian II to librarian III. While librarian II is generally considered the full performance level for librarians, the revised policy provides the opportunity for further advancement for those librarians who have developed a significant and specialized expertise in an area of librarianship that has had a major impact on the Libraries and/or the profession. As a result of this new policy, in January, the Libraries promoted three librarians to the rank of librarian III. These were the first such promotions since 1990.

Rewards and Recognition

In late June the staff of the Libraries joined together once again at a luncheon and awards ceremony to celebrate both collective and individual accomplishments during a very demanding year. A total of 16 staff members—seven individuals and two teams—were recognized for their contributions in the areas of innovation and creativity, communication and collaboration, results, productivity, and outcome, and community through the Infinite Mile Award program. Awardees received a certificate of appreciation and a cash award.

The Spot Award program kicked off on July 1, 2001. The program consists of a monthly drawing of four names from a pool of submitted "thank you"s. The award is $100 in gift certificates to vendors such as The Home Depot, Amazon.com, and the Cambridgeside Galleria Mall. Over 1,000 thank you notes were received throughout the year and 48 awards distributed.

Training and Professional Development

Responsibility for providing technology training opportunities for library staff is shared by many groups and individuals in the Libraries outside Administrative Services and are mentioned elsewhere in this report. For non-technology training, many library staff avail themselves of MIT's Office for Organization and Employee Development offerings, which are convenient and receive good reviews from attendees, both administrative and support staff.

In addition, a special session of "Giving Performance Appraisals," open to all library supervisors, was scheduled in November 2001 in preparation for the support staff performance evaluation cycle.

Participation in professional organizations and conferences is also an important way for librarian and other professional staff to receive training and keep up-to-date with current technologies and best practices in the library profession. Over two-thirds of the Libraries' professional staff participated in these types of development opportunities over the past year.

In an effort to support the Libraries' fiduciary responsibility in making the best use of the limited funds allocated for professional development and to provide a framework for the fair and equitable application of funding across the system, the Libraries charged a task force this past year with the review of the current policy. The work of the task force included identifying merits or inadequacies in the current policy, seeking out best practices, and recommending policies and standards for the allocation of financial support. The task force completed its work in April and the revised policy will take effect at the beginning of FY2003.

Conclusion

This has been a year of refinement and growth built upon the changes begun during the first year of the reorganized Administrative Services. In almost all aspects, Administrative Services has made progress documenting, streamlining, and evaluating policies and procedures. The continuing goal of Administrative Services is to facilitate the work of the libraries in a seamless manner.

Jim Mullins
Associate Director for Administration

Technology Planning and Administration

FY2002 has been a decisive year for technology planning and deployment in the MIT Libraries, and for furthering the Libraries' role in technology planning for many important initiatives of the university. The Systems Office continues to consolidate and improve the technology base of all library operations, while preparing to absorb the many new developments coming out of the Libraries' new digital library research program. The DSpace program has made considerable progress, and is rapidly becoming one of the major international efforts in building digital library infrastructure and defining its impact on libraries, academia, and scholarly communications. Other research projects have continued to build the MIT Libraries' role in driving the national digital library agenda while we have also become a significant contributor to MIT's many academic computing initiatives (OpenCourseWare and the Open Knowledge Initiative, among others).

Systems Office

During FY2002 the technology-related activities of the MIT Libraries reached even farther into the realms of academic computing and new digital library developments. The Systems Office completed a major project to successfully deploy a new library management system, replacing the Barton online catalog with a state-of-the-art system that prepares us to meet the ever-increasing demands placed on library resources. The Barton system underpins the work of almost all library staff, as well as being of critical importance to the faculty and students of the Institute. Successful management of this transition project avoided any disruption to the thousands of MIT users who depend upon it, and has streamlined the libraries' operations considerably. The new Barton system is fully integrated with other important MIT systems (e.g. SAP, the Data Warehouse, etc.) allowing the libraries to achieve even higher levels of efficiency and interoperability with the automated business systems of the university.

The System Office has also focused on improving the productivity of library staff in several ways: increasing the deployment and adoption of productivity applications (e.g. MeetingMaker calendaring software, FileMaker Pro database software, and Macro Express software for improved automation of highly repetitive tasks) and insuring that the technology tools staff use (e.g. desktops computers, printers, scanners, etc.) are the best possible.

Finally, the Systems Office has been a key contributor to many technology-related initiatives in the Libraries, providing technical expertise and experience in managing complex, innovative, and high-risk projects. The group's contributions to efforts such as ENAV (to improve the ability of the Libraries to support faculty and student use of its many licensed networked scholarly resources), the new Geographic Information System being developed at the Rotch Library for Architecture and Planning, and the Digital Reference project (to bring the Libraries' content experts online), have made those projects possible.

DSpace Project

Great progress was made on many fronts in the past year on the DSpace project, MIT Libraries' joint project with Hewlett-Packard to develop and deliver institutional digital repository services to the MIT community. At the same time that interest in using DSpace at MIT has grown significantly, interest in using the DSpace software platform from other institutions worldwide has rapidly increased. DSpace activities in the past year have put us in a strong position to meet the expectations of all interested parties.

The DSpace software platform has matured from a development system to a stable architecture. Through a program of iterative design, early alpha and beta releases, design reviews, and usability testing, we have arrived at a target internal design and public user interface which we feel will serve the project well over the long term. While there will continue to be additional development and ongoing maintenance of the DSpace system, we expect to be fully prepared to launch a reliable and tested system to the entire MIT community in fall 2002.

The early adopters beta program began in fall of 2001 as an MIT internal beta program. By spring of 2002 we established DSpace communities from a wide range of organizations at the Institute, including a school, a department, a lab, a research center, and the MIT Press. At the end of FY2002 we had begun to load hundreds of titles into DSpace, including technical reports from the Laboratory of Information and Decision Systems, working papers from the Sloan School, backlisted digital books from MIT Press, and articles from the Center for Technology, Policy, and Industrial Development. We also began working closely with faculty from the Department of Ocean Engineering to plan for how to scale up the DSpace system to accommodate large datasets resulting from their research. We have endeavored to quickly incorporate what we've learned from these early experiences into system improvements.

During the past year, a DSpace transition committee consisting of several area heads from collections, public, technical, and systems services, along with DSpace project representatives worked to plan the many critical aspects of launching the DSpace service at MIT. This group met intensively to develop detailed plans and timelines to ensure training, promotion, staffing, service definition, production support, and other issues were brought to light and well-considered early. The committee's work, now complete, was presented to the Libraries' staff and used to guide implementation of the production service. Simultaneously, work funded by the Andrew W. Mellon Foundation allowed us to develop a DSpace business plan, resulting in a full cost accounting of DSpace operations and support.

We are looking forward to the next year of the DSpace project, which will bring the live service to all of MIT; free distribution of the DSpace software platform worldwide; a joint effort to bring DSpace services to Cambridge University through a project of CMI, and to other institutions of higher learning through the development of an early federation program; and the beginning of the follow-on DSpace research project with faculty from the Lab for Computer Science, and additional research staff from HP Labs and the World Wide Web Consortium.

Deja Project

During 2002 the Libraries concluded a project funded by the Andrew W. Mellon Foundation to plan a preservation archive of "dynamic" electronic journals that would be reliable, secure, enduring, and sustainable over the long term. Mellon's request for proposals had previously laid out that it was interested in preserving intellectual content

in large amounts before it was too late to preserve the wealth of research electronic journals are currently making available to the scholarly community.

The Mellon Foundation and librarians realize that e-publications are at risk. Many electronic journals won't survive the vagaries of business bankruptcies and mergers, nor technology's obsolescence and failures. Knowing this, the Mellon Foundation challenged its library-grantees to protect the peer-reviewed research that is published on the web in electronic journals. But effective archiving of electronic materials raises all sorts of challenges. Besides the technological hurdles, there are many organizational, policy and managerial problems. Legal questions as well as educational and cultural issues emerge as some of the most difficult areas to change to enable a smooth transition to archiving electronic journals and an uninterrupted continuation of service to a library's patrons.

Our project involved investigating the MIT Press's own web publication, CogNet. From there we scoured the world of electronic journals to understand more precisely what aspects of electronic journals made them dynamic and what sorts of provisions— digital repositories, tools, standards, and practices—could be used, built, and established to archive their content for the long term.

The successful completion of this project has enabled the MIT Libraries to begin preparing itself for the inevitable reality of collecting, managing, describing, and preserving digital journals as it has done for print journals since the founding of the Institute. Building on systems like DSpace, we have insured that the Libraries are not only prepared to take on this role at MIT, but to be an international leader for this type of activity.

Academic Computing Initiatives

During the past year the Libraries have worked to become an important and effective contributor to the development of academic computing initiatives at MIT. Teaching and learning have always depended on the Libraries as the part of the Institute that has responsibility for the acquisition, management, distribution, and preservation of the record of research and scholarly communication. As much of the teaching and learning activities of MIT faculty and students has begun to migrate to the online, digital environment, the Libraries have successfully migrated with them.

In 2002, the Libraries strengthened its relationship with both the OpenCourseWare and the Open Knowledge initatives. OpenCourseWare (OCW) is a major institutional initiative to bring MIT's educational materials to the Internet, and many of those materials are library-based. The Libraries began a process to help OCW in several ways. We are developing recommendations for the standards and procedures that OCW will use to describe education materials (i.e. its "metadata") to facilitate its discovery by faculty and students, its management by staff, and its long-term viability through preservation. We also worked with OCW staff on envisioning how the Libraries can help support the long-term archiving of digital education materials, as it has traditionally done for some printed material but expanding our role in this arena.

Open Knowledge Initiative is defining new standards in the area of instructional technology systems (commonly called course management systems or learning management systems). These systems have need of long-term digital repositories both to locate useful teaching materials and to house faculty-created digital material. These are significant assets of educational institutions, and their professional management is a critical aspect of the mission of our organization. The Libraries are working together with Information Systems to enable the continued transition from the print and aural teaching tradition to the digital future.

Future Opportunities

The past year has seen many advances in the infusion of technology into the Libraries. A new associate director for technology is now in place, and is actively building a dynamic, innovative, and internationally important program of digital library research. This research will be done is addition to, as well as informing, the mission-critical work of supporting the technology base of the Libraries in its day-to-day work. The MIT Libraries' technology efforts, mirroring those of the institution as a whole, continue to take on new significance in an increasingly networked, digital world.

MacKenzie Smith
Associate Director for Technology

MIT Press

The launching of significant operational and program initiatives, and turbulence in the marketplace characterized our year in FY2002.

We completed the monumental task of making the transition to TriLiteral, a partnership fulfillment venture with Harvard University Press and Yale University Press. Those tasks included the design and building of a 150,000 square foot fulfillment center; the design and implementation of a new state-of-the-art fulfillment management system; the relocation of 7 million books; staff reductions at the press to allow outsourcing of order processing and customer service; the hiring and training of over 80 people to staff the new facility. There were lots of glitches in this complex process, most expected and some unplanned for, and everything was done on time. The new system has already demonstrated its value with speedy turnaround and happy customers. In addition, we should start to experience annual savings at the level of $200K+ beginning in FY2004.

The second major series of events include continuing progress in marrying technology with publishing. We set the last pieces in place in the process of building and managing the digital archive of books and journals and we launched our digital POD initiative tailored to our needs in collaboration with one of our major suppliers, Edwards Brothers.

The Digital Projects Lab, the innovative publishing unit of the press, designed and developed two enterprise-scale online scholarly communities—CogNet and ArchNet. In September we transferred the fully functioning beta version of ArchNet, a site devoted to architects and planners with a special interest in the Islamic world, which was commissioned by the Agha Khan Trust for Culture, to the School of Architecture and Planning. In October CogNet, owned by MIT Press and a content-rich resource for researchers and students in the brain and cognitive sciences, marked its first anniversary as a fee-based service. As of the end of this fiscal year, CogNet is projected to break even (supporting 2.5 FTEs) by the end of the calendar year.

This fiscal year also saw the end of our successful two-year collaboration with Hewlett-Packard Labs' Digital Content and Remastering (DCRM) department. In the spring of 2000, we entered into an agreement with DCRM to provide us with print-on-demand quality files (PDF) for approximately 1,500 out of print books and nearly 300 journal backissues. The files were generated using an image analysis engine developed by the HPL engineers. This digitization and remastering effort has allowed the MIT Press to recover a significant percentage of its stranded assets; these books and journals are now back in print' and available for sale or redistribution. In the spring it was decided to decommission this innovative publishing group, effective July 1, due to lack of funds.

FY2002 was a second tough year for academic publishing, particularly university presses. Continuing dominance in the superstores and build-out of major wholesalers and Internet booksellers like Amazon had filled the pipeline and the bookshelves with inventory, and the university presses enjoyed robust growth in backlist sales beginning in FY1999. There was over-expansion and the inevitable contraction in FY2001, and FY2002 witnessed record returns as a lot of inventory came back. The MIT Press weathered the storm better than most university presses. While gross sales improved by 6.5 percent in FY2002, returns increased by 50 percent to 31 percent of net sales. Frontlist sales continued to be strong (up 4 percent over last year), and European sales were up 6 percent, continuing a robust growth trend.

The downward correction was primarily in gross domestic sales (deep backlist sales down 17 percent), and returns were exacerbated by US and Canadian wholesalers and Internet booksellers restructuring their operations. The creation and implementation of TriLiteral during the year had a negative impact on returns processing in FY2002.

On the bright side, net from the journals operation exceeded forecast for a net gain of $274K. Subsidiary rights sales grew 9 percent to $480K, and bookstore sales reported an increase in net gain to $93K on a sales base of $800K.

In summary, the net from our publishing operations were negative at $1.43M. This does not include TriLiteral transition costs of $965K, or interest costs of $222K. Total loss transferred to the balance sheet as negative reserves at the end of the year was approximately $2.8M.

Table 1. Comparative Operating Results (in thousands)

	FY2002	FY2001	FY2000
Total Net Book Sales	16,344	17,103	18,029
Cost of Sales	7,492	7,341	8,039
Gross Margin on Sales	8,852	9,762	9,990
Other Pub. Income	350	642	182
Bookstore Net	92	74	25
Total Income	9,294	10,478	10,197
Operating Expenses	10,995	10,549	9,996
Net Books Division	(1,701)	(71)	201
Journals Net	274	71	301
Net Pub. Operations	(1,427)	-	502

Highlights from the Book Division

MIT authors:

Brezeal, *Designing Sociable Robots*
Cormen et al., *Introduction to Algorithms*, 2nd ed.
Frankel, *Envisioning Science*
Gerovitch, *From Newspeak to Cyberspeak*
Osterman et al., *Working in America*
Paradis and Zimmerman, *The MIT Guide to Science and Engineering Communication*, 2nd ed.

Among the noteworthy books by non-MIT people from our scholarly and professional program were:

Adler, *Belief's Own Ethics*
Aoki, *Toward a Comparative Institutional Analysis*
Beamish, *Silent Spill*
Brown et al., *The Role of Annuity Markets in Financing Retirement*
Dourish, *Where the Action Is*
Frank, *Phrase Structure Composition and Syntactic Dependencies*
Frankel and Orszag, eds., *American Economic Policy in the 1980s*
Garbade, *Pricing Corporate Securities as Contingent Claims*
Geschwind and Gregg, eds., *Microarrays for the Neurosciences*
Glymour, *Time's Arrow*
Herbrich, *Learning Kernel Classifiers*
Holland et al., eds, *The Human Embryonic Stem Cell Debate*
Hong, *Wireless*
Hoshi and Kashyap, *Corporate Financing and Governance in Japan*
Jaffe and Trajtenberg, *Patents, Citations, and Innovations*
Kraus, *Strategic Negotiation in Multiagent Environments*
Lyons, *The Microstructure Approach to Exchange Rates*
MacKenzie, *Mechanizing Proof*
Marin and Schnitzer, *Contracts in Trade and Transition*
Mason, *Mechanics of Robot Manipulation*
McDermott, *Mind and Mechanism*
McLeod, *Self-Trust and Reproductive Autonomy*
Meyer, *Political Nature*
Mol, *Globalization and Environmental Reform*
Mort, *Building the Trident Network*
Moss, *What Genes Can't Do*
Mueller, *Ruling the Root*
Parsons, *Qualitative Methods for Reasoning under Uncertainty*
Pennock, ed., *Intelligent Design Creationism and Its Critics*
Podvig, ed., *Russian Strategic Nuclear Forces*
Price-Smith, *The Health of Nations*
Prinz, *Furnishing the Mind*
Reiter, *Knowledge in Action*
Rice et al., *Accessing and Browsing Information and Communication*
Roads, *Microsound*
Rohlfs, *Bandwagon Effects in High Technology Industries*
Rosen, *Framing Production*
Searle, *Rationality in Action*
Shin, *The Iconic Logic of Peirce's Graphs*
Smythies, *The Dynamic Neuron*
Solomon, *Social Empiricism*
Sonnert and Holton, *Ivory Bridges*
Steinberg, *Environmental Leadership in Developing Countries*
Steriade, *The Intact and Sliced Brain*
Sterling, ed., *Beowulf Cluster Computing*
Temperley, *The Cognition of Basic Musical Structures*
Van der Aalst and van Hee, *Workflow Management*
Vardalas, *The Computer Revolution in Canada*
Ward, *Dynamical Cognitive Science*
Winter, *Flexibility Principles in Boolean Semantics*
Young, *The Institutional Dimensions of Environmental Change*

New hardcover books for trade and general audiences included:

Brown, *Inventing Modern America*
Burnham, *Supercade*
Carpo, *Architecture in the Age of Printing*
Crimp, *Melancholia and Moralism*
Dyens, *Metal and Flesh*
Field, *Touch*
Finn, *Artifacts*
Gammel, *Baroness Elsa*
Gandy, *Concrete and Clay*
Hoffmann, *Tomorrow's Energy*
Huberman, *The Laws of the Web*
Jacobs et al., *The Boulevard Book*
Kantor, *Alfred H. Barr, Jr., and the Intellectual Origins of MoMA*
Kwon, *One Place after Another*
Laurel, *Utopian Entrepreneur*
Margolis and Fisher, *Unlocking the Clubhouse: Women in Computing*
McDonald, *A Ghost's Memoir*
Moldoveanu and Nohria, *Master Passions*
Nicholsen, *The Love of Nature and the End of the World*
Pesic, *Seeing Double*
Rowe and Kuan, *Architectural Encounters with Essence and Form in Modern China*
Ruscha, *Leave Any Information at the Signal*
Sagalyn, *Times Square Roulette*
Schneeman, *Imagining Her Erotics*
Sellen and Harper, *The Myth of the Paperless Office*
Thomashow, *Bringing the Biosphere Home*
Thompson, *The Soundscape of Modernity*
Wegner, *The Illusion of Conscious Will*
Welter, *Biopolis*
Whiteley, *Reyner Banham*

Books published primarily as texts included:

Akmajian et al., *Linguistics*, 5th ed.
Baldi and Brunak, *Bioinformatics*, 2nd ed.
Becker et al., eds., *Behavioral Endocrinology*, 2nd ed.
Biermann and Ramm, *Great Ideas in Computer Science with Java*
Bruce, *Foundations of Object-Oriented Languages*
Carter, *Foundations of Mathematical Economics*
Cytowic, *Synesthesia*, 2nd ed.
Dayan and Abbott, *Theoretical Neuroscience*
Farmer and Demers, *A Linguistics Workbook*, 4th ed.

Grossman and Helpman, *Special Interest Politics*
Guasti, *Language Acquisition*
Pierce, *Types and Programming Languages*
Wooldridge, *Econometric Analysis of Cross Section and Panel Data*

Editors in the Acquisitions Department included Laurence Cohen (editor-in-chief; social theory, science and technology studies); Roger Conover (art and architecture); John Covell and Elizabeth Murry (economics, finance, and business); Clay Morgan (environmental studies); Barbara Murphy (neuroscience); Robert Prior and Douglas Sery (computer science); and Tom Stone (psychology and linguistics).

Production Department

Desktop Publishing

We presently produce 100 percent of our new titles from PDF files. We scan all art packages using hi-end equipment, receiving electronic files back as hi-resolution files for our use (both application and final PDF files) for print. Our present goal is to convert all final files for electronic or web use for future products and for archiving.

Archiving

To date we have over 595 titles in our archive with RR Donnelley in Allentown, Pa.

RRD is responsible for archiving our front and deep backlist (Classic Series) including all text, jacket covers, and insert files for all our content at present. By archiving our content in various formats, such as application files and PDF files for text, jackets and inserts, we have the ability to repurpose our content for multiple uses.

Edwards Brothers Program

We presently have 44 deep backlist titles from the Classical Series in the archive at RR Donnelley.

We are preparing to implement the EB program for producing and selling one-off titles, and are in the process of converting the balance of the 1,500+ text files and paper covers for these titles to complete the EB POD program. We are working with IT on the Bookmaster purchasing and invoicing details.

SGML/XML

We are in the process of typesetting the text and preparing XML files for Arbib, *The Handbook of Brain Theory and Neural Networks*, 2nd edition, which is due for delivery in the fall of 2002.

Personnel Changes

Robert Kinkaid came on board in May 2001. Bob's responsibilities have included the production and manufacturing of over 300 reprints this year alone. He has been instrumental in assisting the production manager in implementing the EB POD program for both reprints and Classic Series, And he handles some new titles as well.

Janet Timmerman celebrated her six-month anniversary with Production on June 3, 2002. Janet has done a superior job in learning department procedures for composition, printing, and binding for new books. Janet is already a big contributor to the department's workflow, handing close to 30 new titles to date.

Editorial

We have finally filled the electronic manuscript/art coordinator position. This position handles file conversion, version control, manuscript cleanup, inventorying, renaming, and organizing electronic files, evaluating file usability, redrafting art on selected projects, and consulting with authors in electronic manuscript preparation. The person in this position has been trained in TeX (and its variants Scientific Word and Textures). She has also been doing layout for difficult projects and projects on a special fast track and is preparing new electronic art and manuscript preparation guidelines for authors.

The number of manuscripts edited partially or entirely on screen continues to increase. Several editors are now providing edited disks on most of their projects. The editors using Word 97/98 or Word 2000 have been trained in the basics of creating macros and using redlining. In many cases, an initial electronic cleanup on the author's files takes care of mechanical tasks such as conversion to house style, editing notes and references, spell-checking, and reformatting for ease of editing to produce a new, more efficiently edited manuscript.

We routinely receive indexes and other manuscript materials as formatted e-mail attachments as well as on our FTP site; the editors have individual folders on the FTP site and have been trained in the relevant file transfer programs.

We have added new file conversion programs that allow us to convert files from programs such as NotaBene that we were previously unable to read. We have created macros for use on Windows-based machines for cleaning up and reformatting documents. We also now have templates for manuscript breakdowns and figure tags. An editorial template (with built-in cleanup macros) created by Kevin Krugh for Harvard University Press has been employed on selected projects. We have increased our capability for working with a variety of media. In addition to word-processing programs, we have been working in Photoshop, Quark, Excel, PowerPoint, Access, and FileMaker.

We do on-screen formatting of front matter and indexes for camera-ready projects.

Editorial now has a spreadsheet tracking system for all projects, keeping track of page counts (including average pages per manuscript), numbers of illustrations, and other pertinent data for use in analysis of workload and budgets.

A color-coded work log tracks individual editors' projects. An additional log tracks electronic media submitted with manuscripts.

Most of the editors are now working on Windows machines, and most now have Zip drives capable of reading the new 250 Mb disks. We now have a faster, higher-capacity printer devoted solely to manuscript printing.

We continue to serve as a resource for authors with questions about word processing: what programs to use, how to prepare disks for the publishing process, and how to use features available in Word. A new diskette label for authors' use should help us deal with authors' disks and improve file version control.

Design Department

We designed and formatted our entire list of heavily illustrated books on the computer using Quark Xpress, low-resolution scans for placement, and unedited text files from author-supplied disks. Final pages were saved as Postscript and PDF files for internal and outside use.

We created jackets on the computer from concept to mechanical, using figures made possible by scanning and manipulating found art, objects, and/or clippings from printed material, and downloaded images from authors or photo services from various web sites.

We mounted all of our jackets on the web site for internal and author viewing, and archived Postscript jacket and cover files on an FTP site for press-wide and outside electronic use. We created innovative interior designs and modified formats for undergradute and graduate text books in one color to compete with full-color text or trade books. We continue to modify our existing formats to accommodate manuscripts with different needs.

We laid out color inserts on the computer using low-resolution scans for positioning.

Our flatbed scanner continues to aid us in creating jacket images from reflective or transparent art and creating electronic versions of interior images used for dummying.

We assisted our electronic manuscript and art coordinator in the process of examining authors' art packages before they are turned over into the system.

Domestic Sales

Domestic sales have continued many of the downward trends we began to see last fiscal year—continued consolidation, the closure of warehouses, and flattened online sales. A subtle reallocation of online sales has also emerged due to increased reliance this year on wholesaler fulfillment. We have also seen a decline in many booksellers' ability to sell backlist titles and their increased dependence on used book and remainder sales to fill this fiscal gap. It is being debated in the trade whether aggressive marketing and sales of these titles have helped to hamper the backlist and paperback reprint market. Remainders and hurts are now prominently displayed, where paperback reprints used to command attention. Even online, customers are now offered at least one used copy of almost every title we sell. Many times these titles are offered by other online vendors, rather than individuals, but the fact remains that it is easier now, more than ever before, for an author, reviewer, student, or used book vendor to resell books that may have otherwise resulted in a new book sale. Booksellers argue that these books serve as incentives and get customers in the stores where they end up buying new books as well. The jury is still out on this one.

Wholesalers

Our two major wholesalers, Ingram, and Baker and Taylor, have continued to adapt their services to keep up with the evolving market. Five years ago, retail independents were Ingram's biggest customers for MIT Press books. Now, almost 55 percent of our book sales to Ingram go to on-line booksellers, with Amazon making up the largest share. Retail chains like Borders and Barnes & Noble account for 20 percent, while retail independents are at 9 percent. Ingram offers shipping directly to the customer for online booksellers, allowing their warehouse to be used as a surrogate, increasing delivery times and allowing Amazon to keep their stock levels lean. This service also allows many smaller online booksellers, such as frontlist.com, to operate without a warehouse.

Ingram recently closed the last of their smaller warehouses and has opened a state-of-the-art distribution center in Chambersburg, PA, directly across the street from their returns center, strategically located to better allocate returned stock to new customers, rather than returning it to publishers. This is a very welcomed move and should allow Ingram to operate at a higher level of efficiency, meaning fewer returns in the coming year.

Baker & Taylor has benefited greatly from Ingram's reorganization in the past year. Our sales with them are up 30 percent, the majority of this increase resulting from online sales and sales through Yankee Book Peddler, their library wholesale division serving four-year academic libraries. Of all books sold to B&T this year, 34 percent went to online booksellers and 32 percent to Yankee Book Peddler. Only 4 percent of MIT Press sales went to independent bookstores. B&T continues to build their library market and will be launching their eBook Library competitor to NetLibrary this fall. This is an exciting opportunity for eBook revenue, while still maintaining strong print book sales in this market.

Online Booksellers

Amazon, our largest online bookselling customer continues to be our biggest customer, once factoring in MIT Press wholesale book sales that have gone to Amazon. Our

bestselling titles tend to be professional titles in economics and computer science. Here are our bestselling Amazon titles since Jan. 1, 2002:

Title	Author	Copies Sold
The Elusive Quest for Growth: Economists' Adventures and Misadventures in the Tropics	Easterly	1,746
Financial Modeling, 2nd Edition	Benninga	1591
Introduction to Algorithms, 2nd Edition	Cormen	930
Unlocking the Clubhouse: Women in Computing	Margolis	803
The Myth of the Paperless Office	Sellen	621
Tomorrow's Energy: Hydrogen, Fuel Cells, and the Prospects for a Cleaner Planet	Hoffman	544
Out of the Crisis	Deming	459
Sources of Power: How People Make Decisions	Klein	453
Supercade: A Visual History of the Videogame Age 1971–1984	Burnham	432

BN.com is a distant second in online booksales. They have made many attempts to increase their market share, undercutting Amazon's prices and shipping costs, but have made up little ground. In a move indicative of this unfulfilled market growth, BN.com recently sold their Reno warehouse to Barnes & Noble because they were not generating enough business to maintain a dedicated dot com warehouse. Now Barnes & Noble rents out space to BN.com and the arrangement seems beneficial for both companies. Our bestselling BN.com titles since Jan. 1, 2002:

Title	Author	Copies Sold
Intro to Algorithms, 2nd Edition	Cormen	1,064
Econometric Analysis of Cross...	Wooldridge	218
Elusive Quest for Growth	Easterly	168
Intelligent Design Creation and...	Pennock	162
New Economics, 2nd Edition	Deming	154
Out of the Crisis	Deming	153
Financial Modeling, 2nd Edition	Benninga	147
Guide to Econometrics, 4th Edition	Kennedy	133
Macroeconomic Essentials	Kennedy	126

In the past year, BN.com absorbed FatBrain.com into their operations. BN.com acquired FatBrain initially to better position themselves in the corporate sales arena. Unfortunately, this proposition was never given proper support and FatBrain has become the latest dot com casualty in the bookselling world.

Retail Independents

Retail independents have also weathered another rough year. While overall independent bookstore sales are up slightly, sales of MIT Press books are down. Sales of our professional and technical list are finding fewer opportunities in brick-and-mortar stores and continue to have their best sales online.

We've seen the closure of a few key stores including the Bibelot chain in Baltimore and the Georgetown Olsson's. Many key MIT Press stores, as previously mentioned, have been unable to sell our backlist titles as they once had and our sales with them reflect this decline. Some of these stores include Harvard Book Store, Seminary Co-op, and Cody's. Some of our other major accounts, however, are slightly above last year. These stores had extraordinary success with our frontlist and include the World Bank Info Shop, Powell's, Labyrinth, and St. Mark's.

The great hope for independent bookselling was a program call Booksense, launched a few years ago. While many university presses hoped this would lend more attention to books that lacked the marketing budgets of larger trade house books, this has not been the case. It is becoming increasingly difficult to secure prominent space for a book in stores without having to pay large sums in cooperative advertising. This prompted us to focus on key accounts in key regions, mostly stores in urban markets or college towns. We recently ceased using the commission rep services of George Scheer and Associates, who for seven years covered the southeast region for MIT Press. Independent bookstore sales in this region have seen a steady decline. The region is primarily populated with chain accounts that we already serve in-house. Our in-house sales assistant will be working with the remaining key independent accounts by phone and at trade shows.

EBooks

In the last year the eBook craze has subsided and we find ourselves in a strong position to build upon the modest successes we've experienced. We've fine-tuned our internal workflow to allow us to work with our existing eBook partners in an efficient and profitable manner. Our monthly revenues with NetLibrary are consistent and have motivated us to expand our eBook library presence with Baker and Taylor's new library service, ED, to be launched this fall.

We have contracts with Books24x7 and eBrary, and continue to look at new models that fit our workflow, require little cost, and have realistic revenue potential.

Promotion, Publicity and Direct Marketing

Direct Mail

FY 2002 brought some changes to our traditional subject-area direct mail program. The focus of the press's acquisitions in certain areas has shifted, forcing us to reconsider how we reach some of our target markets.

We continued to produce subject-area promotions in all our key discipline areas: political science; economics; science, technology, and society; art, architecture, and visual culture; neuroscience; computer science; cognitive and brain sciences; philosophy; linguistics; and environment. We added two focused brochure mailings promoting titles in computer music and our new book series in bioethics. These were mailed to highly targeted lists of individuals we would not regularly reach through our subject-area catalog mailings.

After reviewing sales from our winter computer science catalog, we decided to eliminate our spring catalog and instead produce focused promotions to individual areas of our computer science list. The areas to be targeted are telecommunications and business computing, computational biology, and new media. These promotions are currently in production and will mail in FY2003. Our plan for the foreseeable future is to continue to produce a computer science catalog on an annual basis, and do targeted mailings to specific areas of the computer science list as the need arises.

Another change this year was to reconsider the format of our direct mail in linguistics from a catalog announcing new and backlist titles to a flyer announcing new books only. This seemed appropriate given the small number of new books in linguistics. We mailed the new books flyer as broadly as the catalog, but at substantial cost savings. We produced a special-promotion reference mailing for Robinson's *Handbook of Automated Reasoning*. Additionally we produced two seasonal announcement catalogs, as well as numerous on-demand flyers promoting individual titles.

Our traceable direct mail sales for FY2002 are $122,660.96. Direct mail sales continue to decline as we compete for customers with online booksellers, bookstores, and even our own web site and exhibit sales. However, we believe that direct mail remains an effective means to reach the professional audiences interested in our titles, who may learn of (or be reminded of) our books through these mailings, but who may elect to purchase them (sometimes at substantial discounts) from retailers or at conferences. Direct mail promotions effectively target individuals to make them aware of both frontlist and backlist books in their areas of interest. They serve to reinforce our text promotion and advertising, and they are important tools for our acquisitions editors in building their lists.

Textbook Sales

In FY2002 we mailed 34 direct mail text promotions to over 90,000 US professors in various disciplines. Approximately 25 percent of those promotions were remails, primarily of economic texts. Highlights included new editions of the bestselling texts Akmajian's *Linguistics* 5th Edition and Farmer's *A Linguistics Workbook* 4th Edition. Wooldridge's *Econometric Analysis of Cross Section and Panel Data* had the highest direct response rate of all the FY2002 text mailings.

There was a nice cluster of new computer science texts including Biermann's *Great Ideas in Computer Science with Java*, Bruce's *Foundations of Object-Oriented Languages*, Pierce's *Types and Programming Languages*, and Hand's *Principles of Data Mining*. Having a cluster of texts in the same discipline enabled us to promote the new texts as well as the backlist. It's a building process rather than a one-time promotion.

Exhibits

The MIT Press exhibited titles at 134 US professional and academic conferences in FY2002. This generated $203,567 in exhibit-reported sales, slightly more than the actual $195,057.06 from FY2001. Overall expenses in FY2002 were $93,350, slightly higher than the $88,124 spent in FY2001.

Here are FY2002's top ten US conferences, ranked by at-meeting sales:

Society for Neuroscience 2001	$31,845
Allied Social Science Association/American Economic Association	$11,700
College Art Association	$8,671
Association for Research in Vision and Opthalmology (ARVO)	$5,768
RECOMB 2002: 5th International Conference on Research in Computational Molecular Biology	$5,179
Computer-Human Interaction	$4,890
Toward a Science of Consciousness, 2002	$4,573
American Political Science Association	$4,375
International Joint Conference on Artificial Intelligence	$3,766
Cognitive Neuroscience Society	$3,712

Advertising

Advertisements for MIT Press books appeared in over 600 trade and scholarly journals and magazines, as well as conference programs and web sites. All of these ads were produced in-house by our advertising manager.

The continued focus of the advertising program is to implement better target marketing and wider exposure, with an eye to new print and online media, while staying

under budget. Major ad campaigns were implemented for *Tomorrow's Energy*, *Douglas Gordon*, *Imaging Her Erotics*, *Artifacts*, *The Myth of the Paperless Office*, *The Human Embryonic Stem Cell Debate*, *Inventing Modern America*, *Reload*, *Concrete and Clay*, *Baroness Elsa*, *Envisioning Science*, and *The Illusion of Conscious Will*.

Advertisements for these books appeared in such publications as *American Scientist*, *Technology Review*, *New York Review of Books*, *The American Prospect*, *Science*, *Chronicle of Higher Education*, *The Nation*, *New Republic*, *Harper's*, *Mother Jones*, *Whole Earth*, *New York Times Book Review*, *The New Yorker*, *Art in America*, *Bomb*, and *Artforum*.

Publicity

MIT Press titles received extensive coverage by US print and broadcast media in FY2002. Here are a few highlights.

The Elusive Quest for Growth by William Easterly was the subject of wide print, television, and radio coverage. Features on Easterly and the book appeared in *The New Yorker*, *Newsweek*, *New York Times*, *Washington Post*, *the Washington Times*, and *Christian Science Monitor*. Positive reviews appeared in *The Economist*, *Forbes*, *Wall St. Journal*, *Foreign Affairs*, and *Washington Times*. Television interviews/features aired on CSPAN's *Book TV*, New England Cable News's *Business Day*, and CNBC-TV's *Business Center*. Easterly did radio interviews with *The Connection* (NPR), *Public Interest* (NPR), Voice of America's *Talk to America*, as well as many other local radio shows across the United States.

Supercade: A Visual History of the Videogame Age, 1971–1984 generated buzz in some interesting places. Van Burnham's nostalgic look at the classic arcade and home video games of her youth was recommended by the *Boston Globe*, *Playboy*, *Artforum*, *Booklist*, *Boston Herald*, *Copley News Service*, DirecTV, *IEEE Spectrum Magazine*, *LA Weekly*, *Library Journal*, *Booklist*, *PSE2 Magazine*, *Next Generation Magazine*, *Publishers Weekly*, *The Fader*, Salon.com, *Village Voice*, and NPR's quiz show *Wait, Wait—Don't Tell Me*.

In a memoir of his own, John McDonald, the ghostwriter of Alfred Sloan's famous memoir, *My Year With General Motors*, tells the little-known story of that classic business book's publication—which GM tried vigorously to suppress. *A Ghost's Memoir* has been favorably reviewed by the *New York Times Book Review*, *Business Week*, *Washington Post Book World*, *Across the Board*, and public radio's popular program *Marketplace*, whose reviewer said, "McDonald has given us what may be the best book about business, and about book publishing, to appear this year."

Inventing Modern America: From the Microwave to the Mouse received excellent notices in the *Boston Globe*, *Kirkus*, *New Scientist*, *Journal of the American Medical Association*, *American Scientist*, *Technology Review*, and *Publishers Weekly*, among others. The author, David Brown, discussed the book on NPR's *Tech Nation*, hosted by Moira Gunn.

Unlocking the Clubhouse: Women in Computing generated broad coverage, including scores of radio and several television interviews for authors Jane Margolis and Allan Fisher. The book was also covered by print publications including the *Chicago Tribune*, *Boston Globe*, *San Jose Mercury News*, *PC Magazine*, *Seattle Times*, *King Features Syndicate*, *Chronicle of Higher Education*, *CNET News*, and *San Francisco Chronicle*.

Peter Hoffmann's *Tomorrow's Energy* also received high-profile coverage. The book was reviewed in *American Scientist*, *New Scientist*, *Foreign Affairs*, *Science News*, *Booklist*, *Chemical and Engineering News*, and *Library Journal*. Hoffmann and the book were featured in two separate articles in the *New York Times*, one of which ran on the wire, as well as articles in *USA Today* and the *Seattle Post Intelligencer*. He was also a guest on NPR's *Science Friday*.

A major feature story in the *New Yorker* generated additional publicity for Abigail Sellen and Richard Harper's *The Myth of the Paperless Office*. The article, by science writer Malcolm Gladwell, discussed the book at length and featured quotations from the authors. This prompted additional interviews for Sellen and Harper, including one that is scheduled to appear in *Reader's Digest* in August.

Irene Gammel's *Baroness Elsa* has received much admiring coverage in New York, including reviews or feature stories in the *New York Times Book Review*, *New York Magazine*, and *Village Voice*. In addition, the *New York Times Magazine* plans a fashion spread inspired by the book and its colorful subject, the dadaist poet and artist Elsa von Freytag-Loringhoven, who will be represented by a model or actress. The piece is scheduled to appear in August of this year and will mention the book.

Electronic Promotion

In FY2002, we again posted announcements for new professional and trade books to email lists, web sites and Usenet groups in relevant fields. During his time here, Jud Wolfskill developed a sophisticated set of databases to generate book announcements and store promotional statistics. It also stores information about relevant listservs and web sites, and this database is now quite extensive, thanks to Jud's efforts and the input of authors and acquisitions editors.

Unfortunately, because of the shift of our web site to a new server some months ago, information on the number of hits our book announcements generated is unavailable to us. However, anecdotal evidence suggests that promotional efforts in this field have continued to attract valuable attention to our books. Once again, books in computer science drew the most interest. For example, Benjamin Pierce's *Types and Programming Languages* was promoted on 24 listservs and web sites. (This represents nearly 70 percent

of those moderators to whom the announcement was sent.) Other well-promoted titles include the second edition of Cormen's *Introduction to Algorithms* (13 lists and sites), McDermott's *Mind and Mechanism* (13), Hebrich's *Learning Kernel Classifiers* (11), Schölkopf's *Learning with Kernels* (11), and *Unlocking the Clubhouse* by Margolis and Fisher (10).

Awards

This fiscal year, the MIT Press continued to increase the number of awards won, with big winners in environment, psychology and neuroscience, art and architecture, computer science, and design. Four books received two or more awards—*Hands on the Land: A History of the Vermont Landscape* by Jan Albers; *The Boulevard Book: History, Evolution, Design of Multiway Boulevards* by Allan B. Jacobs, Elizabeth Macdonald, and Yodan Rofé; *Times Square Roulette: Remaking the City Icon* by Lynne B. Sagalyn; and *Environmentalism Unbound: Exploring New Pathways for Change* by Robert Gottlieb.

Following is a summary of all awards won from July 2001 through June 2002.

Continuing its winning streak from last year, *Hands on the Land: A History of the Vermont Landscape* by Jan Albers was lauded for its contribution to the knowledge of the culture, landscape, and architecture of New England and North America. The Pioneer America Society (PAS) presented its Fred B. Kniffen Award to *Hands on the Land* as the best new book published about the North American cultural landscape. The Society for the Preservation of New England Antiquities (SPNEA) presented *Hands* with its annual prize for the book that best advances the understanding of the architecture, landscape and material culture of New England and the United States from the seventeenth century to the present.

Six MIT Press books were honored in five separate environmental awards.

Two of the American Political Science Association's (APSA) sections presented the MIT Press with awards. The Science, Technology, and Environmental Policy (STEP) section awarded two books with a prize for the best book on environmental policy published within the last three years. *Domestic Sources of International Environmental Policy: Industry, Environmentalists, and U.S. Power* by Elizabeth R. DeSombre won the 2001 Lynton Keith Caldwell Award and *Waste Trading among Rich Nations: Building a New Theory of Environmental Regulation* by Kate O'Neill won the same award for books published in 2002.

The Land That Could Be: Environmentalism and Democracy in the Twenty-First Century by William A. Shutkin was chosen as the Best Book in Ecological and Transformational Politics by the section on Ecological and Transformational Politics of the APSA.

For the second year in a row, an MIT Press title received the Harold and Margaret Sprout Award of the International Studies Association's Environmental Studies Section. The award recognizes the best book on the topic of international environmental affairs. *Environmental Leadership in Developing Countries: Transnational Relations and Biodiversity Policy in Costa Rica and Bolivia* by Paul F. Steinberg was the 2002 winner.

Environmentalism Unbound: Exploring New Pathways for Change by Robert Gottlieb, has been selected as a finalist for the 2002 C. Wright Mills Award presented by the Society for the Study of Social Problems (SSSP).

In addition, *Environmentalism Unbound* was a Bronze Award Winner in the category of Environment in the ForeWord Magazine Book of the Year Awards. *Infinity and Perspective* by Karsten Harries was a Bronze Award Winner for Philosophy and *The Boulevard Book: History, Evolution, Design of Multiway Boulevards* by Allan B. Jacobs, Elizabeth Macdonald, and Yodan Rofé was a Silver Award Winner for Architecture. *Bandwagon Effects in High Technology Industries* by Jeffrey H. Rohlfs was a finalist in the category of Business.

The Boulevard Book: History, Evolution, Design of Multiway Boulevards by Allan B. Jacobs, Elizabeth Macdonald, and Yodan Rofé won the award for Excellence in Design and Production in the 2001 Professional/Scholarly publishing Annual Awards Competition sponsored by the Association of American Publishers (AAP/PSP). *The Handbook of Developmental Cognitive Neuroscience* edited by Charles A. Nelson and Monica Luciana was a winner in the category of Single Volume Reference: Science. And *Times Square Roulette: Remaking the City Icon* by Lynne B. Sagalyn received Honorable Mention in the category of Architecture and Urban Studies

Times Square Roulette: Remaking the City Icon by Lynne B. Sagalyn and designed by Michael Sims and Yasuyo Iguchi, was also recognized along with other MIT Press titles in The 2002 AAUP Book, Jacket, and Journal Competition, which notes excellence in design. *Times Square Roulette* was recognized in the category of Scholarly Illustrated along with *Reyner Banham: Historian of the Immediate Future* by Nigel Whiteley and designed by Emily Gutheinz. *Touch* by Tiffany Field and designed by Patrick Ciano was a winner in the category of Jackets.

Two prestigious prizes were awarded to MIT Press authors in the fields of art and architecture. James S. Ackerman, author of the 2001 book *Origins, Imitation, Conventions: Representation in the Visual Arts*, won the International Balzan Foundation's 2001 Balzan Prize in the history of architecture, which includes town planning and landscape design.

Carolee Schneemann, author of The 2001 book *Imaging Her Erotics: Essays, Interviews, Projects*, won the Jimmy Ernst Award in Art presented by The American Academy of Arts and Letters. The $5000 prize is given to a "painter or sculptor whose lifetime contribution to his or her vision has been both consistent and dedicated."

Two photography awards feature a sampling of our prominent photography books and authors. The 2002 Infinity Award for Writing presented by The International Center of Photography for excellence in the field of photography was awarded to Ariella Azoulay for her book, *Death's Showcase: The Power of Image in Contemporary Democracy*.

Karl Blossfeldt: Working Collages edited by Ann and Jürgen Wilde was chosen as the Best Historical Monograph for 2001 by photo-eye Books as part of the annual Best Photography Books of the Year Awards. The awards were announced in *photo-eye*'s 2002 spring catalogue.

Three prestigious awards in psychology and neuroscience were awarded to MIT Press books and authors for outstanding work in these ever evolving fields. *The New Cognitive Neurosciences, second edition* along with editor-in-chief Michael S. Gazzaniga won the 2002 William James Book Award presented by the Society for General Psychology, Division One of the American Psychological Association. This award is given for the book that best assembles research and ideas from the various sub-fields of neuroscience and psychology.

James McClelland and David Rumelhart, authors of *Parallel Distributed Processing: Explorations in the Microstructure of Cognition*, won the 2002 University of Louisville Grawemeyer Award for Psychology for their work in the field of cognitive neuroscience on a cognitive framework called parallel distributed processing and the concept of connectionism. A $200,000 cash prize accompanies the award.

An Odd Kind of Fame: Stories of Phineas Gage by Malcolm Macmillan received this year's prize for Outstanding Book in the History of the Neurosciences presented by the International Society for the History of the Neurosciences.

MIT Press titles were well represented in awards given in the fields of computer science and information science. *From Gutenberg to the Global Information Infrastructure: Access to Information in the Networked World* by Christine L. Borgman was presented with the ASIS&T Best Information Science Book Award by the American Society for Information Science and Technology. The award is given to the author(s) whose book is judged to have made the most outstanding contribution in the field of information science during the calendar year preceding the ASIS&T annual meeting. The award was presented Wednesday, November 7, 2001 at a banquet during ASIST's annual meeting in Washington, D.C.

In recognition of their outstanding leadership and service in the field of computer-human interaction a number of MIT Press authors have been chosen as recipients of awards given by The Association for Computing Machinery's Special Interest Group on Computer-Human Interaction (ACM SIGCHI). The CHI Lifetime Achievement Award has been awarded to Donald A. Norman, author of *The Invisible Computer: Why Good Products Can Fail, the Personal Computer is so Complex, and Information Appliances are the Solution.* The following MIT Press authors have been elected into the CHI Academy: John M. Carroll, author of *Making Use: Scenario-Based Design of Human-Computer Interactions;* Sara Kiesler, co-author of *Connections: New Ways of Working in the Networked Organization;* and Thomas K. Landauer, author of *The Trouble with Computers: Usefulness, Usability, and Productivity.* The awards were presented at the CHI 2002 Conference, April 20–25, 2002 in Minneapolis, Minnesota.

Beyond Our Control?: Confronting the Limits of Our Legal System in the Age of Cyberspace by Stuart Biegel was a Finalist in the 2001 Communication Policy Research Award presented by The Donald McGannon Communication Research Center.

The following books have been honored in the Independent Publisher Book Awards 2002 (The Ippy Awards) presented by *Independent Publisher—Inventing Modern America* by David E. Brown was the winner in the category of Science and *Supercade: A Visual History of the Videogame Age, 19711984* by Van Burnham was a finalist in the category of Popular Culture.

Gabrielle Hecht, author of *The Radiance of France: Nuclear Power and National Identity after World War II*, received the 2001 Edelstein Prize (formerly the Dexter Prize) presented by the Society for the History of Technology (SHOT). This award recognizes the author of an outstanding scholarly book in the history of technology published during any of the three years preceding the award.

The MIT Press was recognized in 2001 for an outstanding contribution to the advancement of management knowledge when *Disappearing Acts: Gender, Power, and Relational Practice at Work* by Joyce K. Fletcher was chosen as a finalist in the George R. Terry Book Award presented by the Academy of Management.

In the field of economics, *The Economics of Risk and Time* by Christian Gollier received the Paul A. Samuelson Award presented in January 2002 by the TIAA-CREF Institute for outstanding scholarly writing on lifelong financial security.

Finally, Jürgen Habermas was awarded the Peace Prize of the German Book Trade by the Association of Publishers and Booksellers of the Federal Republic of Germany. This prize is given to "a personality who has in an outstanding degree contributed to the realization of the idea of peace

particularly by his or her activity in the field of literature, science and art." The award was presented during the Frankfurt Book Fair at St. Paul's Church in Frankfurt, Germany, on Sunday, October 14, 2001.

International Sales

MITP's FY2002 export sales came in at $5.007 million—down just 0.07 percent from previous fiscal year. A worldwide economic slump and a strong US dollar against most foreign currencies were two leading reasons MITP exports remained more or less flat against prior year, as well as continuing long-standing problems in Canada with the Chapters and Indigo chains. Total export sales of $5.007 million during FY2002 accounted for approximately 30 percent of overall book sales for the MIT Press.

For an industry-wide perspective, *Publishers Weekly* reported in its March 18, 2002 issue that US book exports fell eight percent in 2001 to $1.7 billion. Exports to 11 of America's 15 largest book markets fell, and the dollar value of book exports to those major trading partners, which comprised 88.6 percent of all exports, dropped 8.4 percent to $1.52 billion, according to figures from the US Commerce Department.

MITP's London office sales increased to $3,482,000, up 6.2 percent from prior year. London office sales remained slightly above budget for most of the fiscal year. Sales in Great Britain amounted to $1,775,820 or 51 percent of total London office sales, and European sales amounted to $1,706,180 or 49 percent of total London office sales, using exchange rate GBP 1.00 = USD 1.47 on June 28, 2002.

Though this has been a challenging year, many of the problems in other parts of the world did not directly affect the UK economy to the same extent as they did the US economy. The British trade has not been buoyant, returns have been higher than desired, and sales rep calls remain difficult with chains such as Waterstone's and Ottakers; yet MITP turnover at most independent UK shops increased slightly due to efforts by sales reps, who concentrated on specialist shops which still offer knowledge-based service to customers. Academic sales in the fall and holiday retail sales in December were much stronger than anticipated. Central buyers of the Borders Group UK now see our representatives, and we are making some progress with buyers at Amazon.co.uk.

In Europe, one of the factors beyond our control this past fiscal year has been the strong US and UK currencies, making American and British books very expensive and difficult to sell and booksellers hesitant to order stock. Another problem for many of our European booksellers has been the high shipping costs for ordering single titles into Europe from John Wiley & Sons Ltd., our distributor for the UK and European markets; the expensive postal rates resulted in some booksellers canceling backorders and/or in routing their orders via UK wholesalers for consolidated ordering and more economical shipping. The Euro currency was introduced on January 1, 2002, and so far there seems to be mixed reaction to it from our European trade customers. There was good news for consumers in Sweden, where VAT (valued added tax) on books dropped from 25 percent to 6 percent, also on January 1, 2002.

Top 10 European markets for MITP by sales were Germany, $288K; Holland, $196K; Sweden, $143K; France, $113K; Italy, $102K; Norway, $100K; Denmark, $87K; Spain, $80K; Switzerland, $71K; and Belgium, $68K. Sales to Eastern Europe totaled $54K, up 19 percent from prior fiscal year, and sales to Russia were $14K.

Sales to Canada of US$231K fell for a second year, declining 26 percent from FY2001 sales of US$314K, and tumbling 47 percent from FY2000 sales of US$597K. The strong US dollar and the increase in US postal rates did not help us in this market, yet our biggest problem in Canada was the long-standing non-payment and returns situation concerning the old Chapters account and old Indigo Books account (previously the leading two book chains in Canada), which resulted in purchase orders being held for most of the fiscal year. The good news is that in April we settled the accounting and returns problems for these two old accounts, and we established a new account at TriLiteral for Indigo Books and Music Inc., the mega-book chain formed last year when Indigo Books' parent company, Trilogy Retail Enterprises LP, purchased the Chapters chain. We are now very optimistic that the Canadian market will bounce back for us in FY2003. During FY2002, sales of MITP student texts accounted for 70 percent or US$163K, overall sales to Canada.

Japan sales declined 30 percent to $454K, from prior year. Japan's ongoing economic and political woes led to reductions in library budgets this past year, which resulted in fewer orders from our key library wholesaler United Publishers Services Pte.; our sales to United Publishers Services declined by 29 percent this year. MITP sales to the two major book retailers in Japan are down—Maruzen by 24 percent, Kinokuniya Bookstores by 28 percent. The Japanese book trade is feeling the impact of online bookstores on individual purchases—as evidenced by the recent closure of Jena Bookstore (art and architecture books) in the Ginza district of Tokyo, and English-language book departments at Maruzen's Osaka and Hiroshima stores. Now Japan seems to be emerging, perhaps temporarily, from an 18-month recession, its worst in a series of slumps since 1990. The *NYT* reported in June of 2002 that Japan's government recently declared that the economy had "bottomed out," yet despite a recent 1.6 percent rise in consumer spending, Japanese consumers are still hunkering down. Unemployment in Japan remains relatively high at 5.2 percent; wages are eroding; and 173,000 people filed for personal bankruptcy last year, four times the number in 1995. Graduates face the worst job

market in half a century as manufacturers shift operations to China, where young engineers can be paid a fraction of what Japanese earn. Overall, there remains a gloomy outlook for the national economy in the coming year or two.

Sales to Australia increased 17 percent to US$168K, over prior year. This was welcome news, considering that the weak Australian dollar hit an all-time low against the US dollar and made imported books even more expensive than before. Australian consumers and booksellers seem to have adjusted to the introduction of GST (a national goods and services tax, in effect since July 2000), which raised book prices an average of 10 percent. These days the main feedback from booksellers in this market is postage "sticker shock"—their reaction to increased U.S. postal rates for single title or small orders. For Australian publishers and booksellers—particularly booksellers in and around Sydney, who have had a rough time these past two years—sales have stabilized and optimism has replaced the previously prevailing doom and gloom attitude.

Bright spots among Asian markets were in exports to Taiwan, which increased 32 percent to $162K. The gain was led by increased units for two International Student Edition texts: Hoy's *Mathematics for Economics* 2nd Edition, and Cormen's *Introduction to Algorithms* 2nd Edition. Sales to South Korea increased by 14 percent to $106K; sales to Singapore increased by 52 percent to $101K; sales to China increased by 57 percent to $46K; sales to Hong Kong increased by eight percent to $45K. The majority of sales to these Asian markets have been to textbook suppliers and to library suppliers.

Export sales to Latin America remain challenging, with Brazil, Mexico and Puerto Rico the only really active markets for us this past fiscal year. Sales to Brazil increased by 5 percent to $48K, sales to Mexico declined by 2 percent to $55K. All our export activity to Argentina dried up due to the Argentine economic crisis. In Puerto Rico we are currently pursuing adoptions for select texts, and we currently service a few English-language book importers in Jamaica, Venezuela, Colombia, and Chile. Sales strategies and changes in representation for the Latin markets, are currently under review.

FY2002 export sales to the Middle East region (ex. Wiley UK) increased by 48 percent to $92K, with the majority of sales billing to academic and library suppliers in Turkey, Egypt, Tunisa, U.A.E, Cyprus, Lebanon and Jordan. The significant increase in export sales to this region is mainly due to a change in sales representation to Anthony Rudkin and Associates of Oxford, England, and to a greater focus on these markets by our London office.

MITP sales to India (ex. Wiley UK) increased 26 percent to $64K from prior fiscal year, and sales to South Africa decreased 25 percent to $19K.

Table 2. FY2002 International Book Sales by Major Area

	FY2002 Actual	FY2001 Actual	+ / - %	FY2000 Actual	+/- %
Australia	$169K	$143K	18	$172K	-17
Canada	$231K	$314K	-26	$597K	-47
Japan	$455K	$601K	-24	$626K	-4
UK/Europe	$3.482M	$3.280M	6.2	$3,190 M	3
Other Export	$670K	$702K	-4.5	$741K	-5
Total Export	$5,007M	$5,040 M	-0.07	$5,327 M	-5

Subsidiary Rights

Our subsidiary rights program has at its core the sale of translation rights to our books. The income generated by the licensing of foreign rights increased by 14 percent since FY2001. The number of contracts signed increased by approximately 10 percent during FY2002. In particular, we are licensing more Chinese simplified character editions, and activity in Eastern Europe, especially Poland and Russia, has increased noticeably. Total income from translations remains spread evenly between backlist and frontlist titles. Our strongest disciplines in the translation market are economics, computer and cognitive science.

A significant shift over the last few years has been the increase in income from our reprint program, which includes permission to photocopy and to publish excerpts from our books, as well as the sale of paperback reprints. In the category of reprint sales, we continue to license selected English language reprints in those markets where we forecast limited income from sales of our own editions.

Income from our reprint program increased by 6 percent since FY2001, and constitutes a substantial portion of total subsidiary rights income.

During FY2002 income from sales to book clubs decreased by 69 percent since FY2001. This market is the least predictable for subsidiary rights; it depends both on our publishing list and on the financial formula required by book clubs.

Income from the license of electronic rights during FY2002 more than doubled over the preceding year. The bulk of this income is derived from subscriptions to the online edition of *The MIT Encyclopedia of Cognitive Science*. The category of electronic rights is somewhat misleading: we make a distinction between sales of the entire book in electronic form and sales of portions of books for which we receive royalties on the basis of frequency of access. Only the second category is included as subsidiary rights income.

Overall, subsidiary rights income in FY2002 increased by 9.3 percent over FY2001.

Table 3. Subsidiary Rights Income FY00-FY02

	FY2000	FY2001	FY2002
Translations	$198,668	$184,081	$210,766
Reprints	$206,484	$243,988	$258,881
Book Clubs	$4,098	$7,298	$2,271
Electronic, AV rights	$3,574	$3,996	$8,047
TOTAL	**$412,034***	**$439,363**	**$479,965**

*Please note that this total reflects disbursement of royalties due an author who requested payment before the end of the royalty year.

Journals

IN FY2002, the journals program earned sales of $5.7 million, an 18 percent increase over last year, and had a net gain of $273,755 compared to last year at $71,304. The deferred subscription reserve account balance is $2.3 million.

Three new journals were added: *Asian Economic Papers*, *Molecular Imaging, and PAJ: A Journal of Performance and Art*. Six journals were terminated or left our program by the end of the fiscal year: *Markup Languages*, *NBER Frontiers in Health Policy*, *NBER Innovation Policy*, *NBER Macroeconomics*, *NBER Tax Policy and the Economy*, and *Studies in Nonlinear Dynamics and Econometrics*.

The division ends the fiscal year publishing 35 journals. The others are: *American Journal of Bioethics*, *Artificial Life*, *Computational Linguistics*, *Computer Music Journal*, *Design Issues*, *Evolutionary Computation*, *Global Environmental Politics*, *Grey Room*, *Harvard Design Magazine*, *International Organization*, *International Security*, *Journal of Architectural Education*, *Journal of Cognitive Neuroscience*, *Journal of Cold War Studies*, *Journal of Economics and Management Strategy*, *Journal of Industrial Ecology*, *Journal of Interdisciplinary History*, *Journal of Machine Learning Research*, *Leonardo*, *Leonardo Electronic Almanac*, *Leonardo Music Journal*, *Linguistic Inquiry*, *Neural Computation*, *Neurology and Clinical Neurophysiology*, *Presence*, *October*, *Perspectives on Science*, *Quarterly Journal of Economics*, *Reflections: The SoL Journal*, *The Review of Economics and Statistics*, *TDR: The Drama Review*, and *The Washington Quarterly*.

Over the past year the Journals Division has made significant improvements to our web site including increased content, linking partnerships, mailing lists, electronic media, and a new interface design. We now serve movies, sound, pictures, supplemental pages, and applications for journal articles. All journals that provide the MIT Press with forthcoming tables of contents are now listed on the site. In some cases we have TOCs listed a year in advance of the article publication. Mailing lists are now built into the user account management system. Users who create a profile on our site will be able to subscribe to various lists with one click. Presently, we net over 100 new subscribers to our lists per week—an improved sign-up average of 6 lists.

In addition, the Journals Division was heavily involved with MIT CogNet, our electronic community in the cognitive and brain sciences. In FY2002, CogNet successfully emerged from an experimental prototype to a business product. Although it is not financially self-sustaining yet, its membership is steadily growing. Despite minimal marketing efforts, CogNet's paid institutional site licenses has increased by more than 20 percent from 2001 to 2002. In addition, during that same timeframe, all but two subscribing institutions did not review and their reason was due to lack of funds.

CogNet ended the fiscal year ahead of its sales goal with 68 paid institutional site licenses and approximately 80 trial subscriptions.

Frank Urbanowski
Director

Chancellor

The Chancellor's Office was re-instituted by Dr. Charles M. Vest, president, on August 1, 1998. In recreating the office, the president transferred a number of responsibilities from the Office of the Provost to the Office of the Chancellor. These include broad oversight for graduate and undergraduate education, student life, international initiatives, strategic planning, and the management of selected Institute large-scale partnerships.

The chancellor is committed to advancing the goals outlined in the 1998 Report of the Task Force on Student Life and Learning. In the simplest terms, the report states our goal of advancing the environment for learning, research, and community. Whether it is our exploration of new ways of teaching, new campus facilities, enhanced student life programming, supporting fraternities, sororities, and independent living groups (FSILGs), or implementing the new Communication Requirement, we are dedicated to ensuring that we make steady progress in realizing the vision set forth in the report.

Planning for Residence System Redesign

As construction proceeded on Simmons Hall and renovations occurred in dining facilities, committees proceeded with plans to accommodate all first-year students on campus and open a new residence facility. The Office of the Dean for Student Life, under Dean Larry G. Benedict, assumed responsibility for the implementation of the residence design system and did this in cooperation with Dean Robert L. Redwine's Office for Undergraduate Education to ensure that orientation and other first-year program activities were well articulated with the new emphasis on design.

The budget for FY2003 includes significant new resources to support student life and residential reprogramming.

A committee continued work to assist fraternities, sororities, and independent living groups in anticipating and preparing for the transition that will include the absence of freshmen as residents in the first year. This planning activity included not only addressing the financial implications, but assisting the FSILGs in strategic planning and development of new recruitment activities and, generally, strengthening their internal operations and external presentation. The plans for new programming for campus residences include the specific goal of encouraging, to the extent possible, the participation of FSILGs in campus programming.

Graduate Housing

Progress continued in the development of the new graduate dormitory at the corner of Sydney and Pacific streets, which will provide 750 beds when opened. The period 2001 and 2002 saw the first year of the Albany Street graduate residence. In both these developments, we substantially increased the number of beds available for graduate students. New programming by the Office of the Dean for Graduate Students, under Dean Isaac M. Colbert, greatly increased the community building efforts aimed at strengthening graduate student life. Additional plans have been developed for 2002–2003. The budget for FY2003 includes additional resources to support graduate life and community building.

Approximately eighty beds in the graduate inventory have been set aside to address the undergraduate-crowding problem. The beds that we set aside may be required for as many as five years. In AY2001 and AY2002, we experienced a significant problem with undergraduate crowding. The system overall was approximately 120 beds short. This shortage affected as many as 400 students. The crowding problem was the result of over-enrollment (more than 1,000 new students) in the previous three years as well as two consecutive years of decline in the number of first-year students electing to live in FSILGs.

To address the housing crowding problem in undergraduate housing, a limited number of undergraduates will be assigned to graduate housing. In addition, the number of new students, including transfers, will be limited to 1,000 for fall 2002. This reduction in the number of new students and temporarily setting aside beds in graduate housing are expected to address the crowding problem.

To address future issues in housing, the chancellor appointed a Housing Strategy Group chaired by Deans Benedict and Colbert. Student leaders, representatives from the dormitory and FSILGs councils, staff from the deans' offices, the chair of the faculty, and housemasters comprise the Strategy Group. The group will advise on strategic and operational issues related to housing.

Student Mental Health

The Task Force on Student Mental Health submitted its report to the chancellor in September 2001. The task force recommended a number of changes to our approach in addressing student mental health. They found that a substantial number of students would benefit with more information from student health and that parts of the system needed additional resources and coordination. While suicide in the late 1990s represented one impetus for the creation of this task force, the major goal reflected in the task force recommendations, in the efforts of the Chancellor's Office, the Medical Department, and the deans' offices, was to create a more caring and more supportive community and to align our resources with that goal.

In response of the recommendations of the task force and based on the extensive community dialogue in September and October 2001, the following changes occurred, among others:

- The appointment of a clinical director of campus life
- Authorization of new staff positions in the Mental Health Department
- Appointment of health education professionals
- Expanded evening hours for clinic visits
- Better coordination between student life and medical personnel
- New protocols for transportation and notification
- A web site with health and wellness information and resources
- A number of pilot programs aimed at introducing a better method of connecting students with medical professionals and information outreach.

Further response to the recommendations of the task force as well as an evaluation of this will occur in the coming year, as new staff begin their work.

Council on the Environment

The chancellor serves as co-chair of the Council on the Environment with Professor David H. Marks from the Department of Civil and Environmental Engineering and the Laboratory for Energy and Environment.

The council worked on a variety of initiatives. It led the effort to broaden the base of the Alliance for Global Sustainability, collaboration between MIT, the University of Tokyo, and the Swiss Federal Institutes of Technology. A spring conference in Costa Rica provided an opportunity for more than thirty faculty as well as a large group of students to participate. The chancellor and the council also worked to support other research centers and programs related to energy, the environment, and climate changes. The year saw the implementation of a space consolidation of environmental activity in Building E40.

The Chancellor's Office supported the development of a new program initiated by Professor Mario Molina (Chemistry and EAPS), Professor Lawrence Susskind (DUSP), and Dr. Luisa T. Molina (EAPS) to provide an educational program in environmental management for mid-career professionals supported by the Mexican government. This is a professional, master's degree program sited in the Urban Studies Department. If the model with the Mexican government proves successful, this might be the basis for an environmental management degree emphasis for other developing countries.

The Council Sub-Committee, headed by Professor Jeffrey I. Steinfeld, together with other members of the council, reviewed our initiatives in undergraduate education and activities related to the environment. They concluded that while there were a number of worthwhile efforts these were uncoordinated. The effort was a substantially underdeveloped presentation of environmental opportunities for undergraduates at MIT. The group made recommendations for better program coordination, for the identification of minors, student activities, internships, UROP, and other activities that will be promoted in FY2003.

The council supported the establishment of the first proposed Earth Systems Initiative led by Professors Ronald G. Prinn (EAPS), and Rafael L. Bras (Civil and Environmental Engineering), now led by Professors Sallie "Penny" W. Chisholm (Civil and Environmental Engineering) and Kip V. Hodges (EAPS). The program will have both a research and educational component. The educational component, Terrascope, will provide an integrated opportunity to achieve freshmen program goals as well as an introduction to the study of the earth as a system. Both pre-freshmen and an academic year programs will provide an opportunity for a significant number of students to receive this exciting introduction to the study of the environment at MIT. The research program will provide an opportunity for more than three dozen faculty members who have related research interest to pursue activities that take advantage of both science and engineering in understanding the earth as a system.

Media Lab Europe

The chancellor serves as a member of the board of directors of Media Lab Europe. This is a laboratory supported by the MIT Media Lab and funded by the Irish government. The lab, located in Dublin, Ireland, was established to bring the MIT Media Lab's unique culture of innovation and invention to Europe. In partnership with industry and the MIT Media Laboratory, Media Lab Europe plans to use an interdisciplinary approach to developing new, sustainable technologies that empower people to lead more fulfilling lives. Media Lab Europe scientists share a vision of a world in which technologies serve the purpose of human performance, community and well-being. The areas of high priority include: education and games, wireless applications, physical health and well-being, and technologies to support collaboration. The economic downturn has forced the lab to pursue other partners in addition to industry. These potential partners are drawn from foundations and European governments.

Media Lab Asia

The Media Lab also has spawned an activity in India. Media Lab Asia is an effort funded by the Indian government to explore how to bring empowering technology to the task of developing rural communities. The past year was spent exploring whether such a laboratory is possible and whether it is possible to assemble the partnerships and resources. Based in Bombay, the lab would have satellites in other major Indian cities with outreach to rural areas. Directed by Professor Alex "Sandy" Pentland, the lab would provide opportunities for students and research fellows to design and test a variety of technologies to advance education, health, communications, and development.

Day Care Initiatives

The chancellor serves as chair of the Special Child Care Committee. In 1999, the provost established the committee to guide the implementation of an initiative to expand child daycare opportunities to serve faculty and staff at MIT as part of the development of the Stata Complex. The committee has focused its work on designing and programming the daycare facility, opening the end of 2003. During the past year, major design and program decisions were made that will assure the facility will provide daycare service for infants and toddlers, that the opening of the center will be articulated with the change in management and some upgrading of facilities at Eastgate and Westgate, that MIT will provide overall supervision of a contract to Bright Horizons, who has been retained to manage all daycare at MIT, and that the operational responsibility for supervising the contract will rest with the Human Services Department and the Family Life Center.

New Community Initiatives

The chancellor has taken the initiative to encourage a number of efforts to enhance community life and leadership development in the community. Dr. Kirk D. Kolenbrander, special assistant to the president and the chancellor, assists in these efforts. Recent efforts have ranged from coordinating activities in response to the terrorists' attacks on September 11, 2001, to plans for an anniversary commemoration on September 11, 2002, with follow-up activities.

The Chancellor's Office also sponsored an environmental scan led by Francine J. Crystal, organization development consultant, Human Resources, to identify conceptions of community life and to develop approaches to strengthening and building community.

In February 2002 the Chancellor's Office sponsored a conference of student leaders and held a meeting in May 2002 to bring all the various campus leadership initiatives together to explore what next steps might strengthen their individual areas as well as the overall campus initiative. A number of these initiatives and funding to support new initiatives has been included in plans for 2002–2003.

Industrial Partnerships

The chancellor appointed a committee chaired by Professor Glen Urban. The charge to this committee is to review the following partnerships that have been initiated in recent years: Amgen, Merck, Merrill-Lynch, Ford/MIT Alliance, Nippon Telephone and Telegraph, Dupont, Microsoft, and Hewlett-Packard.

While some of these partnerships have expired, several of them continue. Some will come up for review or renewal in the next few years. The committee's review and report will assist the faculty and the senior administration in:

- Assessing the value of this approach to partnering and research development
- Defining how future opportunities for partnering might be addressed
- Assisting academic units in learning from the experience of units that have had successful initiatives
- Identifying how partnering can be more effectively implemented so that its benefits are spread and it problems are minimized

In entering these partnerships, MIT had several goals. In these industrial partnerships, MIT has sought to:

- Increase research support for faculty
- Develop new strategic relationships with new or existing industrial partners
- Renew or create infrastructure to support teaching or research
- Develop and test new models of distance education
- Support curriculum development
- Support student exchanges, internships, etc.
- Gain access data and other resources from partner firms
- Enhance the excellence of MIT through gifts, endowments, fellowships, and other support

While initiatives vary in the degree to which they explicitly embody each of these goals, each initiative pursues some combination of these goals. The committee will explore the extent to which the initiatives have made progress on these goals and what other results have been obtained, including unintended or negative ones. The committee worked over the spring and summer and submits its report in fall 2002.

In other developments, MIT and Ford agreed to extend for another five years the MIT-Ford Alliance that expires at the end of 2002. Major research projects continue in areas of environment and advanced technology. A new emphasis on active safety emerged and matured in 2001–2002 and will be a major part of the continuing work.

MIT continues its partnership with Merrill Lynch. Recent work focuses on the financial technology and global issues that drive the future of consumer finance.

Cambridge-MIT Institute

This past year thirty-two MIT students attended Cambridge University in the United Kingdom through the undergraduate exchange program of the Cambridge-MIT Institute (CMI). These students, like the pilot group that preceded them, had an excellent experience in Cambridge. Approximately the same number of Cambridge students studied at MIT. Faculty at the two institutions have begun several joint curricula projects.

In addition, several MIT faculty and Cambridge faculty spent time at each other's institutions as part of the fellowship program, research collaborations, and in workshops and other venues. Project topic areas included energy efficient building design, Rhodococcus (a bacterium that processes a key drug for AIDS), novel mmaterials, quantum information theory, advanced bio materials, microelectromechanical systems (MEMS), ceramic encapsulation of nuclear waste materials, and the development of stem cell bioreactors.

CMI began four professional master's programs arising from collaborations with MIT faculty. Programs in bioscience enterprise, technology policy and environmental engineering, and sustainable development have been developed.

The Cambridge Institute also underwent an organizational review to create an executive committee and other organizational changes that streamline decision-making and operations. An Industrial Summit in the fall of 2001 brought together leaders of British industry for briefing on research projects.

Phillip L. Clay,
Chancellor
Professor of City Urban Studies and Planning

Dean for Graduate Students

The national landscape of graduate education, never a pristine vista, has for the past several years been progressively littered with especially rocky outcroppings:

- The increasing intensity of the competition among elite universities for the best students. Formerly accepted understandings that moderated competition among schools have been replaced by unfettered willingness to offer high stipends, attractive housing, relocation funding, and amenities one typically associates with corporate or sports organizations. This reality stimulates MIT to examine previous assumptions about our competitive position and to fashion measured responses.
- Heightened concern about international students, in the wake of the September 2001 terrorist attacks, now etched in the national psyche as "9/11." INS rules have been tightened, understandably, but with the effect of making it more difficult to bring international students across national borders. (See the report of the International Students' Office.)
- The increasing presence of unions as public and private universities struggle to cope with rising demands of graduate students for attention to their needs and concerns.

How are these new realities surfacing at MIT, and what kinds of positive responses are suggested?

The union movement clearly represents a decidedly dramatic shift from the conventionally passive role of graduate students and reflects an emerging view of them as active, assertive partners in the enterprise of advanced education. While the immediate focus has been on teaching assistants and the extent to which those appointment and their attendant responsibilities imply employee status, we also saw efforts to include students serving as resident assistants in residence halls and others in similar positions. In the past year, private institutions that formerly enjoyed blissful insulation from the mostly public university–focused unionization movement began to see union campaigns develop and achieve startling successes. In circles of graduate deans there has been alarm at these developments, which challenge the traditional relationship between faculty and graduate students, especially at the elite private schools. However, it's not unreasonable to say that the motivation for unionization has followed from universities' pervasive willingness to exploit their graduate students for low-cost teaching and as occasional substitutes for roles better suited to professional staff. The contention that teaching assistants are not employees but students is rapidly losing ground in every quarter of higher education, and in many cases universities have only themselves to blame.

Graduate teaching assistants at MIT represent only a small fraction of our graduate body, about 8 percent of nearly 6,000 registered students. The majority of others are supported as research assistants by faculty research contracts, have internally or externally provided fellowships or traineeships, or pay their own way. Most of those who teach do so as an integral part of their graduate education or because they want the experience. In those areas where research support is not strong and where teaching has traditionally been the sole source of support, aggressive efforts to raise fellowship funding are progressing. Graduate teaching should be encouraged and enabled at MIT as a vital element of the educational experience, but reliable support should be expanded for those whose fields are not well funded by research contracts.

If another impetus for collective bargaining lies in nonexistent or deeply flawed relationships among graduate students, administration and faculty, then there is reason for a positive outlook at MIT. To be sure, there have been and will always be tensions arising from incompatible goals of students and administration, from financial exigencies that limit available funds, and from other factors. However, there has been growing cooperation between the administration and graduate student leadership on an increasingly broad set of issues and problems:

- Graduate students participate meaningfully on numerous Institute committees, enjoying a role in decision making that has become extensive.
- Students responded in large numbers (46 percent) to a recent survey asking about their principal needs and concerns, demonstrating their willingness to inform discussions. Our responsiveness to these voices should demonstrate the administration's willingness to listen.
- When graduate students have been included in decision making and given access to relevant information, they have risen to each occasion to provide astute analyses, clever potential solutions, and responsible help in generating acceptance of proposed solutions.
- Of particular significance to the GSO in the past year has been the responsiveness of graduate students to the development and expansion of "graduate community" at the Institute.

The spirit of mutual cooperation has grown. This trend is a welcome one, and the Graduate Student Office is committed to its continuation.

The reports that follow will give concrete examples of how the trends and issues introduced above have been reflected in GSO activities of the past year.

Isaac M. Colbert
Dean for Graduate Students

Graduate Student Life—Programs and Services

Graduate Women's Group

In its fifth year, the Graduate Women's Group (GWG) continued to provide a supportive network for graduate women students at the Institute. Group membership reached more than 150, with approximately 50 women students actively involved in GWG initiatives throughout the year.

The bimonthly informal lunch discussions served primarily as a forum for building relationships and "community" across department boundaries. Many of the women who participated in GWG gatherings or other activities had common concerns and issues, experienced comparable challenges, and met similar "invisible barriers" to success. For them, the GWG became a "safe" place to talk about both painful and pleasant aspects of graduate life, and helped them to cope with and work through the tough moments.

Over the past five years, the co-sponsors of the GWG, associate dean Blanche Staton and Lynn Roberson from the Office of Counseling and Support Services, have consistently encouraged the students to empower themselves by sharing the responsibility for their success and general well-being. This year, the GWG students responded to this charge by developing significant new initiatives, and some women students became active "working" members of the Graduate Student Council.

Perhaps the most striking initiative and visible example of the GWG's impact was the creation of a women's group for graduate students in the Department of Electrical Engineering and Computer Science (GW6), founded by three members of the GWG. In late winter, a few Chinese GWG members announced their interest in hosting an event to bring together Chinese women graduate students. A dinner sponsored by the GWG attracted more than 40 women. Building on the previous year's lunch discussions on the topic of the challenges and rewards for women in academic careers, one graduate woman led a brainstorming and discussion team to generate ideas about how better to support and prepare graduate women for academic careers, and clarify the obstacles to choosing such a career. This activity remains a work in progress.

Graduate Women's Book Club

The Graduate Women's Book Club continued to thrive as a way for students from different cultural backgrounds and academic disciplines to come together socially around a common interest. The women met frequently, with 12–15 women actively participating throughout the year, including summer. The GSO covered the cost of the books.

Career Development

The GSO augmented the Institute's career development agenda by sponsoring programs and events specifically for women graduate students. For example, on April 11, 2002, the director of leadership at the Sloan School, Robert Greenley, arranged to broadcast a leadership conference live from New York, Washington, DC, and London. Hosted by Womenfuture, Inc., the event featured women leaders of multinational companies and government agencies who discussed timely topics of business. The GSO offered a private showing to the GWG, and the GWG co-sponsors facilitated feedback discussions following each segment of the conference.

Also during spring term, Hannah Bernstein, who specializes in career services for graduate students, met with the GWG to hear about their interests, issues, and concerns, as well as inform them of the resources available through the Office of Career Services and Preprofessional Advising.

The GSO's partnership with Mentornet, an e-mentoring network for women in engineering and science, continues to be valuable to graduate women students. Associate dean Blanche Staton manages the relationship among students, MIT administration, and Mentornet. In fall 2001, the program paired 25 graduate students with mentors in industry, providing a framework for them to pursue a year-long mentoring relationship. The students benefited from an increased understanding of how work life differs from student life as well as the planning process for the transition from school to work. They also benefited from contact with a mentor who has pursued a career path of interest to the student, and access to networks and other resources, which often lead to opportunities for internships and jobs. Also, more than 25 undergraduate women have used Mentornet's services, to which they are entitled because of the GSO's partnership status. The GSO expects participation levels to increase among all women students as Mentornet continues to expand its services.

Recently, the GSO arranged for the executive director of Mentornet to meet with representatives from the Office of Career Services and Preprofessional Advising, and the Alumni Association, to discuss the breadth of services available to MIT. Many of the program's mentors are alumni of MIT; in fact, Mentornet might help the Institution connect with and track the activity of "lost" alumni.

Key Student Constituencies

On September 12, 2001, the GSO sponsored the fifth annual reception to welcome new graduate women to MIT. It was the day after tragedy struck our nation, leaving pain, anger, confusion, and devastation in its wake. Perhaps the need to reach out and touch someone, or the search for a smiling and welcoming face, or simply the chance to talk

to someone who understood, drew more than 80 people. Newly enrolled graduate women were joined by continuing students, women faculty, and administrators. New students seized the moment to get acquainted, ask questions, and learn about resources. Said one new student, "I am encouraged by the support on campus. I also found it so exciting to see so many women of all races pursuing their PhDs!!! It was invigorating."

The GSO's goal of enhancing the quality of life for graduate women students has focused new attention on graduate women who are parents. The office offered advice and provided financial support for activities aimed at creating opportunities for "graduate moms" to share experiences and interests, learn about resources for families, and present their issues and concerns to the larger MIT community. The Graduate Student Council assigned a representative to serve as a liaison to the "graduate moms group," more student parents moved into leadership positions to represent the voice of the student parent community, and new initiatives have been put in place to respond to their needs.

Looking forward, in addition to sustaining the current level of support for graduate women students, the GSO will explore possible strategies for responding to graduate students' requests for stronger communication skills and more opportunities to meet women in leadership positions in both the academy and industry. The GSO intends to collaborate with the International Students Office and international student interest groups on campus to better understand and more proactively support graduate women from other countries.

The GSO reaches out to and supports the graduate student community of color in significant ways throughout the year, through individual counseling, financial support for group events, and planning ongoing initiatives, for example, the Power Lunch. This monthly lunch hour forum has been a way for minority graduate students to gather socially, share issues and concerns, exchange "best practices" for navigating the PhD, and learn something that has value to them either educationally, professionally, or personally.

This past year, for example, Dr. John Davis from the Research Division of IBM shared his views about what it takes to be successful in graduate school and in the workplace. Hannah Bernstein and Deborah Liverman from the Office of Career Services and Preprofessional Advising delivered a presentation and facilitated a discussion on networking—for information, influence, and resources—as a career development strategy. Dr. Suze Prudent, a psychologist on staff at MIT, offered techniques for stress management and described common causes and effects of stress. Students responded particularly well to MIT staff, and many contacted the MIT presenters individually for follow-up conversations.

Graduate students of color have expressed an interest in connections with graduate alumni of color as well as more exposure to leadership development activities. Over the next year, the GSO will collaborate with the Alumni Association, individual graduate alumni, minority faculty, and student organizations, to identify and implement appropriate activities.

Blanche Staton
Associate Dean for Graduate Students

Recruitment

The major goal for the 2001–2002 recruitment season was to strengthen relationships with the growing number of university contacts. Over the past few years, the GSO has had an increasing involvement in two major initiatives: the NSF-funded University of Massachusetts at Amherst Alliance for Graduate Education and the Professoriate (AGEP); and the Ford Motor Company/MIT Recruitment Initiative. These programs have increased the number of faculty contacts at some institutions and added institutions to the recruitment roster.

Through campus visits, conferences, phone and email follow-up, the GSO has maintained and strengthened its campus networks at various targeted institutions. Faculty contacts are receptive to outreach efforts and welcome additional opportunities to collaborate. The various recruitment efforts have created a need for consistent annual visits to ensure that MIT's interests are recognized on these campuses each year.

Summer Research Program

The MIT Summer Research Program was also gearing up for another full year of activities, beginning with the recruitment of applicants. After experiencing a dip in the number of applications in AY2000, the GSO increased the mailings of internship applications to include new contacts in AY2001. This additional outreach was intended to complement the traditional mailings to various individual contacts and directors of the following national programs: Minority Access to Research Careers; Minority Biomedical Research Support; and the Ronald McNair Program. (A mailing to approximately 30 directors of the Alliance for Minority Participation program was postponed until next year.)

Even with the slight increase in outreach, the number of applications this year remained the same, although there was some diversification in the mix of schools represented.

Through funds made available by the Howard Hughes Medical Institute (HHMI), private foundation grants, and NSF resources (available through AGEP, mentioned above), 14 slots were available in the Summer Research Program. This number was lower than the usual 30 due to completion of several long-term grants and an imbalance

in the requests for engineering placements as opposed to science placements. Nearly 70 percent of student applications were for engineering opportunities, with less interest in interdisciplinary areas of study where available science funds could be applied. Nevertheless, offers were made to fill all 14 slots (11 students accepted), and the program entered its seventeenth summer with 11 students placed in research positions.

In June, HHMI notified the GSO that funding had been renewed for the next four years; this guarantees support for 15 student slots with the potential for five additional slots later. Although this is good news, the GSO is determined to rethink its outreach strategy and to try to identify more diverse funding in support of the program.

Looking Forward

Looking ahead, the GSO anticipates rethinking its recruitment strategy. Increasing pressure from NSF and NIH has refocused attention on what departments are doing to increase the number of students at the graduate level who are underrepresented minorities. In addition, an infusion of new, enthusiastic faculty over the past few years has helped to rejuvenate the interest around this effort. With this in mind, a proposal has been laid out under the umbrella of a collaborative leadership project initiated within the GSO to include eight academic departments.

Faculty from these departments will work closely with the GSO to assist with recruitment roadwork; support the summer research program logistics; and document the one-year collaborative experience. Hopefully, with increased faculty involvement in off-campus recruitment efforts, MIT will improve its ability to identify and attract the appropriate applicants and increase the number of underrepresented minority students who matriculate into MIT graduate programs.

In addition, faculty will act as liaisons for the Summer Research Program, helping to identify potential mentors and assisting with placements. This faculty support may help the increasingly difficult mentor recruitment process, which suffers from competition with UROP and the inclination on the part of faculty to work with students with whom they can develop more long lasting relationships.

Just as essential to the success of the effort will be the documentation of this experience with participating departments—each with unique interests and resources. Documenting the business processes that develop in this recruitment effort will provide a glimpse at the work entailed in establishing a truly proactive institutional graduate recruitment effort on the graduate level.

Roy Charles
Assistant Dean for Graduate Students

Graduate Student Council

During the past year the Graduate Student Council worked energetically to represent graduate students and advocate for improvement of the graduate experience at MIT. Through successful programming and active advocacy, the GSC continued to be a major contributor to student life. The GSC worked together with students, faculty, staff, and alumni to produce a number of successful events and will continue to do so in the future.

While cooperation between the GSC and the administration was generally close, towards the end of the academic year several communications breakdowns occurred. Going forward, the GSC will work proactively to improve the communications and participation by students on major decisions that affect them.

The following is a summary of the main topics and events that the GSC focused on during the past year.

GSC Orientation Activities

The past year was an extraordinary one in that over 1,000 new students participated, and over 100 volunteers helped; the "Graduate Student Volunteer Day" program was initiated; a banquet for alumni company representatives brought back over 100 alumni; orientation welcome packets were expanded and significantly improved; and MIT's GSC received two prestigious awards from the National Association of Graduate and Professional Students.

Career Fair 2002

Co-sponsored by the senior class, the Society of Women Engineers, and Office of Career Services and Pre-professional Advising, the annual career fair was once again successful. Despite the chilling effects on travel following the events of September 11, 185 companies participated. Profits from the fair were used to fund the GSC Travel Grant program along with other GSC-sponsored activities.

Professional Development Series

This series of workshops was designed to address a variety of questions about options and opportunities for students' careers. Participation was strong this past year, as the series attracted hundreds of students and continued to be a popular program.

Grad School 101

Co-sponsored by the Graduate Students Office and organized with Dean for Graduate Students Isaac Colbert and Professor Steven Lerman, the Grad School 101 series is designed to improve the first-year experience by directly introducing students to important issues such as advising, funding, and dealing with problems.

Offered for the second time this past year, the seminars convened in the various graduate residence halls. The site change encouraged a substantial increase in student participation. In the future, the GSC plans to work with Dean Colbert and Professor Lerman to develop and post on the web an expanded set of notes associated with the seminars.

Other GSC Program Highlights

A new leadership initiative, "Leading," was initiated, attracting over 100 participants. This initial success guarantees that the program will continue in the future.

The International Mentoring Program, offered in conjunction with the International Students Office, continued to be a successful effort, having doubled the participation of the prior year.

Run4Kids brought together hundreds of students, faculty, staff, alumni and local residents in a unique fundraising effort for area youth. The activity helped to improve relations among MIT graduate students and the Cambridge community.

Alumni events and interaction increased substantially, especially during Career Fair Week and through a continuing series of social events sponsored by the GSC.

TechLink continued to hold increasingly popular events co-sponsored by the GSC and the Sloan Senate. Both large and specially targeted vents offered many opportunities for interdepartmental networking and general socializing opportunities among campus-resident and off-campus graduate students.

Participation in the annual GSC Ski Trip doubled to nearly 400 students. The event typically attracts a many first-year students, but the past year saw increased general interest in the activity. Other trips during the year were also sold out, indicating the desire by graduate students to participate in social activities off campus.

Graduate Nights events provided live entertainment on campus every other week during the year. The events are so successful that they are becoming a permanent addition to GSC programming.

GSC Advocacy

During the past year the GSC advocated assertively regarding issues that directly affected graduate students. Among the highlights of that advocacy were the following:

- Working together with the GSO, dean for student life, and Housing the GSC reviewed the proposed rent schedules for graduate residence halls. GSC recommendations for system-wide rents were adopted. Through the coming year the GSC will continue to work with these offices through a new standing group that will work on a variety of housing and related issues.

- The GSC had active representation on the Campus Dining Board, which recommended a new dining system. The recommendation has been well received by the entire student community.
- Active representation of the GSC in the Mental Health Task Force helped develop the final report for that group.
- Continued work on stipends and benefits to ensure the most positive experience by graduate students
- The *Graduate Student News* not only published five printed issues, but also created an online version that can be continuously updated. The GSN is the only publication on campus solely devoted to graduate student issues and advocacy.

Throughout the past year the GSC, together with the GSO, successfully brought to the attention of the administration and faculty several graduate issues that required attention. As a result, graduate students were increasingly invited to participate in discussions and serve at full members of committees that had formerly not been accessible. At the same time, though, the student body was not involved initially in several major decisions. These included the decision to house undergraduates in graduate dorms, rent structures, the student life fee, and outside bank accounts. The lack of involvement at the initial stages of decision making remains an issue.

Future Considerations

For the coming year, the GSC has identified four major focus areas, as follows:

- *Communications.* The GSC must work better with the administration to learn about emerging issues, and to solicit views and opinions of graduate students at the earliest stages of consideration. Success in this area will improve the ability of the GSC to serve as an advocate for the needs of MIT's graduate population.
- *Effective advocacy.* As the graduate students' primary advocate, the GSC must work to communicate to the graduate student body its understanding of issues and gather opinions of the graduate community to reflect to the administration for collaborative decision making.
- *Internal collaborations.* A major goal of the GSC is to work more closely with groups internal to MIT. This includes the administrations, departments, offices, and student groups. The GSC must increase its presence within MIT by modeling how to work collaboratively.
- *Accountability.* GSC officers and executive committee members must work to ensure that all parties working with the GSC are responsible for their duties. Representatives must strive to reflect their constituents; members serving on Institute committees must give regular feedback to the GSC and must carry the ideas of students to those committees. Finally, the GSC and the MIT administration, faculty, and staff must continue working actively and positively together.

International Students Office

The mission of the International Students Office is to help the international student population at MIT fulfill academic goals by providing services and support programs that facilitate adjustment to a new academic and cultural environment. The office assists students in maintaining their legal status in the United States, provides support for their dependents, and promotes their interaction with and integration into the MIT community at large. In addition, the ISO advocates for a broader awareness in the MIT community of issues salient to the international student.

The events of September 11, 2001, have impacted nearly every aspect of the work the ISO does on behalf of international students at MIT. The Institute and the ISO, in those first few weeks after 9/11, demonstrated in word and deed a strong commitment to international academic exchange. Chancellor Phillip Clay's eloquent public statement on September 12, reconfirming the Institute's commitment to diversity and its concern for the international community, was both comforting and appropriate for students in the immediate aftermath of those horrific events. Those early efforts went a long way toward making our international population feel valued and supported and therefore able to carry on with the academic research that brought them to MIT in the first place.

The subsequent flurry of executive and legislative activity required thoughtful and expeditious reaction and written response to Vice President for Federal Relations John Crowley, as well as to Senator Kennedy's office in Washington. Numerous meetings with senior Institute personnel were convened in efforts to re-examine, restate and/ or revise Institute policy on issues such as release of information, Institute protocol with federal agencies such as the FBI, procedure for foreign nationals dealing with "select agents," access to and disclosure of scientific information, and foreign travel for Institute-sponsored trips and research.

Under normal circumstances, the ISO spends fall term reflecting about and evaluating the previous international admissions and orientation cycle, from review of web page communication to office policy and procedure to advisor/student appointments. All of this important work was "backburnered" as the ISO attempted to untangle, comprehend, and cope with the myriad statutory as well as attitudinal challenges confronting our students.

By spring term, the ISO needed to focus on the day-to-day anxieties of international students and respond appropriately to the far-reaching implications of the Office of Homeland Security, the USA Patriot Act, and the Enhanced Border Security and Visa Entry Act.

Admissions

The ISO plays a pivotal role in admissions, enabling international students admitted to MIT to secure their visas, arrive in a timely fashion, and orient themselves culturally and legally to life in the United States and at MIT.

September 11th has not slowed international graduate applications to the Institute. Most graduate departments saw a steep rise in the number of foreign national applicants—for example, the Department of Electrical Engineering and Computer Science fielded a record number of 2,821 applications to their graduate program, nearly half of whom were international applicants. A high percentage of those internationals were admitted. Similar trends have been reported in many graduate departments across the Institute, especially in engineering and management programs.

International students admitted for 2002 (approximately 700 in graduate programs, 100 undergraduates) faced a new array of security measures, delaying their visa issuance and subsequent arrival at MIT. For example, all males applying for student visas, regardless of nationality, were subject to a supplemental visa form DS-0157, which requires detailed descriptions of military training, travel and employment histories, and academic/research interests. Additionally, admitted students (or returning students) from the following countries were asked to submit to additional security measures, lengthening the visa approval (or denial) process by a minimum of 20 days: Afghanistan, Algeria, Bahrain, Djibouti, Egypt, Eritrea, Indonesia, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Malaysia, Morocco, Oman, Pakistan, Qatar, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, United Arab Emirates, and Yemen.

Graduate admits from the People's Republic of China (PRC) faced extraordinarily rigorous scrutiny at the US embassy and consulates. A majority of newly admitted PRC students had visas denied on first and second attempts. The ISO spent an inordinate amount of time walking through the visa interview process with admitted PRC nationals by phone or via email. MIT faculty consulted the ISO regularly as they drafted appeal letters to consular officials for students whose visas were denied.

Peer institutions across the country experienced the same trend in PRC student visa denials during the spring and summer of 2002, which may have little to do with new security measures. The University of California at Berkeley discovered a spate of fraudulent documentation from student applicants from the PRC, including transcripts, recommendation letters, and immigration documents. Such reports as well as "immigrant intent" issues seemed to be the motivation behind visa denials. Last year, with heavy ISO intervention, most PRC admits were able to get visa

denial decisions overturned. To date, it is still unclear if the ISO will achieve that level of success with PRC admits for AY2003.

All six Iranian admits were denied student visas. Ostensibly, like the Chinese, the reason given by State Department officials was "immigrant intent," but Iran's designation as a "state sponsor of terrorism" may be the underlying factor.

Admission numbers increased steadily, with the MEng programs and the visiting student category especially appealing to foreign nationals. In January 2002, the Institute imposed a $1,000 fee on host departments for each visiting student they wished to invite. Despite the fee, departments continue to invite visiting students in record numbers. On any given day, there are over 120 active visiting students on campus. The ISO manages the visiting student fee account on behalf of the Institute, but does not have access to these monies.

Visiting students continue to tax the ISO from legal and advising perspectives. They often arrive with little or no notice, or in inappropriate immigration status. The ISO has a clear procedure in place but because agreements are often made between the inviting faculty member and the individual student, critical legal steps can be overlooked, creating serious immigration fallout. On the advising side, visiting students often have problems competing with regularly enrolled MIT students for physical space in labs and departments, and difficulties finding accommodations in the Cambridge area since they are not entitled to on-campus housing. Hopefully, the Institute will consider giving a portion of the visiting student fee to the ISO to support much-needed specialized programming for this growing group of visiting students.

The Cambridge-MIT Alliance (CMI) also expanded its group of students on campus this year. Aside from the 51 academic-year exchange student admits (up by 22 from last year), the program brought in 27 international visiting students for an eight-week summer course. The ISO prepared special immigration documents to accommodate the unique aspects of this program, in addition to designing a customized immigration orientation program. Though these internationals are full-time students at Cambridge University in the United Kingdom, they are not all UK citizens. A significant percentage come from countries that are now subject to enhanced scrutiny. Despite the short-term, fully funded nature of the CMI program, these participants fall under the same federal mandates as regular international students in MIT degree programs.

As every new program and alliance has its own admission idiosyncrasies, the ISO has become proficient in applying legal admissions requirements to new realities. Given the current budget and staffing limitations on the ISO, it will be challenging to meet these demands over the next few years if the nation's war on terrorism escalates, creating further statutory requirements for all non-immigrant students entering the United States.

Advising

Advising remains at the core of the ISO's responsibility to MIT's international students. Thousands of students have received advice on immigration procedures and regulations for travelling, employment, and change of visa status. Through individual appointments, as well as increasingly more sophisticated use of websites and email, the three advisors stayed busy providing legal and personal advice to prospective students, admitted students, current students, and graduated students (who continue to seek counsel long after commencement).

While ostensibly seeking ISO expertise because INS regulations require it, students also come to the ISO with underlying concerns about cultural adjustment and worries about political tensions at home. The ISO is a place to seek technical information, clarification, advice, comfort, and even protection. It is imperative that the ISO find the resources and staff time to develop programming around critical issues such as mental health, domestic violence, and academic honesty, areas of great concern for international students.

When the Student Exchange Visitor Information System (SEVIS) for student tracking comes online early in 2003, the ISO will need to augment and refine advising skills as the consequences of falling out of status will be much more draconian in the future.

As in the past, advisors have continued to visit students who have been hospitalized, comfort students grieving the loss of a loved one back home, and intervene, on behalf of troubled students, with immigration officers, consular officials, and other government agencies. The workload will increase in both scope and importance as a result of 9/11 legislation.

Orientation

All international students, regardless of age, degree program, or familiarity with life in the United States, undergo a period of cultural adjustment. They, and their dependents, require information about their new surroundings, culture, and community.

Through the website and email, incoming students are now able to address many of their practical concerns before their arrival. Once they are on campus, the ISO provides individual and small-group orientation sessions to all incoming internationals, daily from mid-August to mid-September.

The ISO is legally required to provide immigration information to all new students and to verify that they are in appropriate legal status, and has expanded this mandated orientation to include overall orientation to

Boston and MIT culture. Other social events open to the entire international community included coffee hours, presentations by the Medical Department, the MIT Libraries, and Campus Police.

Orientation culminates this year with an International Student Panel and a Faculty Panel, whose members will provide personal and practical advice for survival at MIT.

Host to International Students Program

HISP provides new students with supportive emotional and social ties to the MIT community. Coordinator Kate Baty has been tireless in her efforts to develop and implement new programs and events. In addition to the traditional welcome barbecue for new students and their host families, Kate and the ISO staff organized potluck dinners for students and host families, which encouraged and solidified cross-cultural relationships within the MIT community. Kate continued to be actively involved with the International Freshman Mentor Program, which matches incoming international freshmen with upperclassmen before they arrive, and encourages their relationship through airport pickups and a bevy of social activities and mentor-organized programming during the first few months after arrival. Now in its fourth year, the mentor program has been staffed and organized entirely by volunteer students, along with volunteer co-founder Paulette Schwartz. The ISO will seek ways, financial and other, to support and expand this invaluable program.

IAP Activities

ISO sponsored workshops of special interest to MIT international students during IAP. The ISO director presented two workshops covering the laws that regulate the employment of F-1 and J-1 student visa holders as they relate to jobs at MIT, summer internships off campus, and employment possibilities after graduation. A prominent Boston area immigration attorney discussed visa options when student visa eligibility ends. MIT's assistant controller Fred Crowley presented a critical workshop about federal and state tax filing requirements for international students. In response to 9/11, the director also held workshops on proposed regulations and new travel requirements.

Future Goals

In the aftermath of 9/11, the next few years will be challenging ones for the ISO. MIT's substantial international student population will be subject more than ever to stringent scrutiny as they embark upon their academic careers at MIT. As predicted in last year's report, SEVIS received an influx of funding immediately after 9/11 and is currently scheduled for nationwide implementation on January 30, 2003. Yet, to date, the ISO does not have precise specifications for the INS database for producing immigration documents for our students. International offices across the country fear that the immigration service is under such enormous pressure to roll out a student tracking system as quickly as possible that they will do so without any systematic, large-scale pre-testing.

The ISO will ensure that its own new integrated internal database is running smoothly, and will be as prepared as possible for SEVIS implementation despite the lack of published INS specifications for the tracking system.

The ISO will stay abreast of new legislative activities and executive orders, informing the community and tracking their actual impact on current and incoming students. The ISO will train new advising staff to be proficient in the new federal requirements imposed on MIT and the foreign nationals who pursue academic programs here. Equally important will be the counseling expertise of the ISO staff. With strong leadership, teamwork, and sustained commitment by the Institute (both financial and otherwise), we look forward, even in these most difficult times, to providing the best possible service to ensure the well-being of MIT's international students.

Danielle Guichard-Ashbrook
Director
Associate Dean for Graduate Students

Dean for Undergraduate Education

During the past year the Office of the Dean for Undergraduate Education (DUE) has seen important progress in a number of areas critical to student life and learning at MIT. The summary in this report discusses some highlights; many more details are contained in the office reports that follow.

Organizational Changes

In September 2001 Elizabeth Reed, formally the associate director of the Office of Career Services and Preprofessional Advising, became director of that office. This appointment followed Chris Pratt's departure for Columbia University. Reed has made a wonderful start in her new position, and clearly commands the strong loyalty of all her staff.

Anna Frazer was appointed assistant dean for the Communication Requirement, and is working closely with the Committee on the Undergraduate Program's Subcommittee on the Communication Requirement on all aspects of implementing this important new feature of the undergraduate curriculum.

Associate Dean Margaret Enders, formally co-director of the Office of Academic Services (OAS), now reports directly to the dean and is responsible for Special Educational Initiatives. Currently she is concentrating primarily on the Cambridge-MIT Institute (CMI) Undergraduate Education and Student Exchange Program and on working with Assistant Dean Anna Frazer on implementing the Communication Requirement, as well as on providing staff support to the Committee on the Undergraduate Program. Professor Kim Vandiver is now sole director of OAS.

The Edgerton Center, directed by Professor Kim Vandiver, was brought organizationally into DUE this year. This seemed a natural home for the center, and we are already seeing synergies with other efforts in DUE.

The Teaching and Learning Laboratory, directed by Lori Breslow, has now spent a full year within DUE. As expected their activities, especially in assessment and evaluation of educational programs, are very much part of the mainstream of DUE efforts.

The Office of Minority Education was relocated to the Infinite Corridor, just across the hall from DUE headquarters. This very visible and central location has been a goal for this office for some time. The Teaching and Learning Laboratory was relocated to the first floor of Building 5. This brings TLL much closer to related DUE and other activities.

Overall DUE offices reflect broad diversity, although there are a few offices which still need attention in this area.

Highlights of Developments and Initiatives in Undergraduate Education

We continue to work with personnel in the Office of the Dean for Student Life (DSL) and others on establishing community as a critical third leg, with teaching and research, of an MIT education. This year a major focus was preparing for fall 2002, when all first-year students will live on campus. DUE activities in this area were intense and varied, and included working to ensure an appropriate and smooth system for housing assignments and the leadership role in designing Orientation for August/September 2002.

DUE continued its close collaboration with the Committee on the Undergraduate Program on a number of important educational issues and opportunities. These included student advising and mentoring, and the implementation of the new Communication Requirement and the change in Pass/No Record for 2002.

The CMI student exchange program continues to be very popular with students from both institutions. This past year about 30 students from each institution took part in the year-long exchange, and it is expected that about 50 from each will take part in 2002–2003. As anticipated, both institutions are learning important lessons about the strengths and weakness of their educational cultures and traditions. We are already using some of these lessons in designing reforms at MIT. There has been encouraging progress in plans for various joint curricular efforts with Cambridge University. A few concrete efforts are now underway, and discussions of possible major reform in engineering education have taken place.

The dean continues his role as co-chair of the Council on Educational Technology. This is an important connection to various efforts at MIT which impact education. This past year, with a lot of collaboration with IS personnel, we sent information to incoming students on what type of computer equipment they might want to purchase before arriving at MIT. Depending on how these recommendation are received and acted upon, we will likely be providing more information in the future.

The d'Arbeloff Fund for Educational Excellence continues to spur important efforts in educational innovation. During the past year, in addition to making decisions on many new proposals, we have paid special attention to encouraging sustainability for more mature projects which appear to be successful.

A lot of background work has been done during the past year to prepare for major upgrades in IT capabilities, especially in the Admissions Office and in Student Financial Services. Some of these upgrades are badly needed and time critical, so we hope we can launch the real efforts in the near future.

The Enrollment Management Group, chaired by the dean, had a number of meetings and complicated discussions before making its recommendations to Academic Council. A major focus this year was the need to eliminate crowding in the housing units, and it appears that in fact we will have done that by fall 2002. This is a most welcome development, with important educational as well as social benefits.

Robert Redwine
Dean for Undergraduate Education
Professor of Physics

Office of Academic Services

The Office of Academic Services (OAS) provides services in broad support of MIT's academic mission. The services are provided by three working groups: Academic Information and Communication, the Academic Resource Center, and Faculty and Alumni Support.

Academic Information and Communication works collaboratively with others in DUE to ensure the accuracy of academic information and to improve its delivery using web-based technology. The Academic Resource Center provides high-quality, student-centered services and advising specifically to freshmen and runs the MIT Freshman Orientation programs. Faculty and Alumni Support provides services to enhance educational initiatives of faculty and to draw alumni into the education of our students.

Academic Information and Communication

The Academic Information and Communication (AIC) section of Academic Services works collaboratively with others in DUE to ensure the accuracy of academic information and to improve its delivery using technology, primarily web-based. AIC also supports the technology that underlies many of the programs offered throughout the Office of Academic Services. Of particular note during 2001–2002 was the role of AIC in working with the Academic Resource Center to support and help develop a freshman database, a first-year web site, and an online freshman advising folder (described under the Academic Resource Center below).

New Initiatives

- Formed a DUE working group on Advising Information that reviewed current DUE web sites and identified best practices. Work is currently underway to design the organization and architecture of a student-oriented site. More information on the team, including a list of members, is available at http://web.mit.edu/acserv/advisinginfo.
- Created an online guide to web site development (http://web.mit.edu/acserv/toolkit) to assist staff on topics relating to web accessibility, usability, site maintenance, and other issues.
- Helped develop and implement new policies and procedures for freshman grading changes in 2002–2003 and the CUP-sponsored experiment with sophomore exploratory subjects in 2003–2004. Revised and wrote guidelines for publication in the Bulletin, the Academic Guide, and on various web sites.
- Contributed to the redesign of the Advanced Placement credit processing system. AIC helped guide the business analysis of system design and is the primary contact with the Educational Testing Service as MIT transitions from tape and hard copy reporting media to fully electronic reporting.

Academic Resource Center

The Academic Resource Center (ARC) provides high-quality, student-centered services specifically to freshmen and all other undergraduate students that significantly enhance their academic success, social adjustment, and assimilation as MIT students. To achieve that vision, the ARC provides access to Institute resources and services that recognize the many needs, diversity, and uniqueness of students at the Institute.

This office is responsible for freshman programming, including orientation, academic advising, choice-of-major programming, learning strategies, and other academic support. Additionally, the management, operation, and oversight of the Undergraduate Research Opportunities Program (UROP) are ARC responsibilities.

ARC organizes and coordinates the Independent Activities Period (IAP) and provides staff support to the Committee on Academic Performance (CAP).

New Initiatives

- Developed a FileMaker freshman database which provides data on fifth-week flags, end-of-term performance, CAP actions, advisors, advising seminars, etc. and reports on all subpopulations that ARC and other departments desire to track. Data are being used to develop intervention strategies and programming to ensure end of term success.
- Inaugurated a new first-year web site (http://web.mit.edu/firstyear) that is updated five times per annual cycle and supports all first year, transfer, and advisor information needs. For its work the first-year web site team was recognized with a DUE Infinite Mile award.
- In AY2002, 16 Cambridge University students participated in UROP through CMI.
- Defined the goals and began implementation of an online freshman advising folder. This folder will include information on Advanced Placement and AP recommendations, advanced standing exams, Freshman Essay Evaluation, math transfer credit, math diagnostic, Freshman Advising Seminar assignment, Mission 2006 acceptance, HASS-D lottery, etc., as well as links to supplemental/support sites. Student Services Information Technology (SSIT) was a partner in this project.

Key Accomplishments

- Both as an office and as part of the Residence System Implementation Team, we worked with RLSLP, housemasters, learning communities, academic departments, OME, Athletics, ROTC, Registrar's Office, students and other stakeholders in finalizing a new orientation schedule for fall 2002.
- Developed and offered a comprehensive professional development program for freshman advisors, including special workshops for new advisors. One hundred sixty-five faculty and administrators advised 1,031 freshmen; this included 76 Freshman Advising Seminars.
- Completed year two of the residence-based advising program with ninety freshmen in McCormick and Next House. The eight seminar and three traditional advisors also served as House Fellows. RBA will expand for AY2003 to include 265 freshmen, 16 seminars, and 11 traditional advisors.
- Collaborated with the dean of admissions and the department head for Athletics, Physical Education and Recreation (DAPER) to modify specific programs within Campus Preview Weekend. The academic and athletic/club sports programs will be organized and overseen by ARC and DAPER. Additionally, facilitated the development of an early admit homepage coordinated with Admissions.
- Orientation 2001 introduced two new student life programs: rape awareness and diversity. Approximately 55 faculty/staff facilitators were trained to support the small group discussions.
- During the Independent Activities Period (IAP) 2002, 565 different non-credit activities were available to the MIT community. One hundred seven for-credit subjects were taught.
- During summer 2001 and academic year 2001–2002, a total of 1,833 students conducted UROP projects, one more student than in 2000–2001. The UROP office allocated $1.3 million to students. Faculty allocations to students through sponsored research or departmentally managed funds reached $5.8 million.
- In AY2001–2002, 72 percent of UROP research was conducted for pay, 26 percent was conducted for credit, and 2 percent was conducted on a strictly voluntary basis.
- In summer 2001, 97 percent of UROP research was conducted for pay, while the remaining 3 percent was conducted for credit or on a voluntary basis.
- Throughout the four-week, highly effective UROP IAP Research Mentor Program, 41 experienced UROPers provided guidance to 82 freshmen.
- UROP's book-value endowment is $8.9 million; the Paul E. Gray Fund for UROP remains the largest individual endowment fund. This past year added three new endowed funds: the Shih-Ming Shih '79 Fund, the Climaco and Carol Metral Fund, and the Class of 1992 UROP Fund.

Faculty and Alumni Support

Faculty and Alumni Support (FAS) provides services to enhance educational initiatives of faculty and to draw alumni into the education of our students. FAS works in support of a variety of d'Arbeloff-funded educational initiatives designed to enhance the undergraduate experience. FAS also partners with the Alumni Association in Alumni Engagement. Alumni Engagement seeks to assist faculty and promote and support alumni engagement in both undergraduate and graduate educational activities, with the mission to harness the experience and intellectual curiosity of alumni by developing educational partnership opportunities that help improve the educational experience of our enrolled students.

New Initiatives

- Initiated a major review to examine processes and content of MIT's Subject Evaluation, with one focus on improving the evaluation of teaching and learning. The working group has members from OAS, Teaching and Learning Laboratory, and Information Systems, and involves various schools.
- Worked with Professor Edmund Bertschinger to identify and recruit alumni as subject experts and as class participants in 8.224 Exploring Black Holes. One hundred twenty alumni applied for 12 class spaces, while six other alumni served as topic experts/speakers.
- Worked with the Graduate Student Council and Undergraduate Association to involve alumni with student activities. Recruited 43 international alumni (many from the clubs of Beijing, Shanghai, New Delhi, and Bombay) as mentors to incoming international graduate students. Helped develop an alumni/student networking dinner during fall Career Fair. Found alumni speakers for programs such as Career seminars, the Leadership Development Initiative for Graduate Students, and Grad School 101. Identified and invited alumni and families to numerous events (e.g., Infinite Buffet, GSC Barbecue and TechLink events, Ashdown House Centennial Celebration, UA Stochastic Dinner).

- Worked with the IAP Office to offer two IAP panels of UROP alumni for undergraduates.
- Recruited alumni for the five-day IAP workshop Discover Mechanical Engineering.
- Worked with the GSC, Tau Beta Pi, and Office of Minority Education to increase participation of alumni as career fair recruiters and to identify and recognize them when on campus.
- Worked with the Undergraduate Practice Opportunities Program to identify alumni to sponsor undergraduate engineering internships.
- Recorded over 300 alumni participations in alumni engagement programs and provided this information for the Alumni Association database.
- Worked with the Alumni Association to expand the Infinite Connection and Institute Career Assistance Network to be available to students in fall 2002 as well as to alumni.

Key Accomplishments

- Increased the number of alumni participating in alumni engagement programs begun last year through identification and recruitment (e.g., 12.000 Solving Complex Problems (Mission 2005) had 37 alumni vs. 18 last year, BioMatrix had 37 vs. 21 alumni mentors).
- Designed and produced a new brochure for faculty teaching and educational enhancement funds supported by the Classes of 1951, 1955, and 1972. Almost twice the number of proposals was received this year versus last (15 vs. 8). Of the 15, 12 were funded for a total of nearly $167,000.
- Provided significant staff support to Professor Kip Hodges and the expanded number of first-year students in 12.000 Solving Complex Problems (Mission 2005).
- Provided administrative support and oversight to a number of scholarship and fellowship programs. Enhanced the Phi Beta Kappa selection process through increased use of electronic information. Fifty-nine (59) members of the class of 2002 were elected to membership in Phi Beta Kappa this year

Office of Academic Services Personnel

A significant reorganization of the Office of Academic Services occurred this year with Dean Peggy Enders forming a separate unit in support of the Cambridge-MIT Initiative (CMI) and the Committee on the Undergraduate Program (CUP). Dean J. Kim Vandiver assumed sole directorship of OAS. The areas remaining in Academic Services are thus Academic Information and Communication, the Academic Resource Center, and Faculty and Alumni Support.

One new staff member was added: Maria Shkolnik, staff associate for educational initiatives (temporary position). Staff leaving OAS to support CMI and the CUP include Peggy Enders, associate dean, and Nancy Crosby, administrative assistant.

J. Kim Vandiver
Dean for Undergraduate Research
Professor of Ocean Engineering

Admissions Office

The goal of the Admissions Office is to identify, recruit, select and enroll the best students in science, engineering and management in the world.

We admit all undergraduate students (freshman and transfers) and serve as a clearinghouse for graduate application paperwork. We work closely with the Student Financial Services Office, the Academic Resource Center, the Registrar's Office and the Alumni Association at various times throughout the year, and with all other offices in DUE, DSL, and the undergraduate departments during Campus Preview Weekend.

Accomplishments

Our applications increased by 2 percent over last year, including a 7 percent increase in Early Action applications. We admitted fewer students (1,719, or 16 percent of the applicant pool) to enroll a mandated smaller class size of 980. Our yield currently stands at 57 percent, down another percentage point, for the third consecutive year, from a high of 60 percent in 1999.

According to our cancellation study, the reasons for not enrolling at MIT depend on whether or not the student was an aid applicant.

The top three reasons why financial aid applicants chose not to enroll:

- their enrolling college's academic atmosphere, meaning that they wanted a more liberal arts culture
- their enrolling school's students
- their enrolling school's financial aid offer

The top three reasons why non-financial aid applicants chose not to enroll:

- their enrolling college's academic atmosphere
- their enrolling college's students
- their enrolling college's curriculum

Nevertheless, the diversity of our entering class is strong—43 percent are women, 16 percent are underrepresented minorities, 28 percent are Asian American, and 8 percent are international.

This year was a year of reorganization and evaluation, brought on by a budget overrun in FY2001. We worked closely with Jeanne Hillery of DUE to clean up all of our accounts, we slashed all non-essential spending and postponed new initiatives except for the web sites listed below, we built an ideal budget based upon the current needs of the Admissions Office including new initiatives, we made individual staff members responsible for specific accounts, we changed administrative officers, and we ended the fiscal year with a surplus.

In the evaluation of our spending patterns, we discovered ways to switch from paper to electronic formats. We moved two of our three biggest mailings—the initial mailing to juniors and sophomores called the Search, and our travel invitations—to an email format. This is risky because it appears that girls are less likely to respond to email, but we have a sense that now is the time to shift over to electronic venues and we'll do a thorough follow-up of the effectiveness of this strategy. In addition, the graduate application and female recruitment brochures are now on the web.

We began the design of three new publications for next admissions cycle. This is significant because Admissions has not produced a new publication in over 4 years, which is its normal shelf life. It takes 9–12 months to design and produce a new publication, which means that we will have these new ones ready for the spring of 2003 recruitment cycle. We are creating a piece for high school sophomores, one about financial aid that will be inserted in the view book which will be sent to juniors as the main search piece, and one to give visitors to campus.

Our newly designed web site for female recruitment, "Your Place in the Infinite," won a Council for Advancement and Support of Education (CASE) silver medal for the category Student Recruitment Marketing. This is our first CASE award in six years. In addition, we designed a new web site for educational counselors that will give them access to the decisions on their interviewees and will include all training modules.

We ran the largest Campus Preview Weekend in its 18-year history: 880 students (52 percent of all admits) and 729 parents. At least 1,500 members of the MIT community participated. Our yield was good (70 percent) but a bit lower than 1999's yield of 73 percent. Students who were placed in FSILGs yielded better than those in dorms. Students who brought their parents yielded better (74 percent) than those who did not (66 percent).

Staffing Changes

The Admissions Office is made up of 15 staff and 17 support staff. This past year we hired 5 new staff members (2 white men, 1 Mexican American woman, 1 African American woman, and 1 Asian woman).

We also hired 4 support staff members (2 white women, 1 white man, 1 Asian woman) to fill available openings.

Marilee Jones
Dean of Admissions

Office of Career Services and Preprofessional Advising

The mission of the Office of Career Services and Preprofessional Advising (OCSPA) is to help students develop the self-awareness and ability to explore, clarify and implement good career choices. Concern about the economy for students and graduates entering the job market set the context for our work this year. However, while the end of the technology-fueled boom of the late 90s sent hiring needs plummeting, so far our graduates seem to have been spared the extremes reported nationwide. The recession produced fewer offers and perks, rather than an acute drop in the number of employers recruiting in OCSPA. The 31 percent decrease (to 388 employers) was less severe than the 35 percent to 50 percent reported by many schools nationwide.

Like last year, consulting (management, economic, etc.) and finance together accounted for a high proportion of this season's recruiters, at 26.7 percent. In AY1996 (the most recent year for which we have comparative data), the percentage was only 16.6 percent. The combined total of biomedical device and pharmaceutical firms increased to 5.8 percent, from a combined total of 3.3 percent in AY1996. Information systems consulting firms declined to 2.9 percent this year, from 8.3 percent in AY1996. Software firms decreased to 14.2 percent in AY2002, from 18.5 percent in AY1996, but the changing mix of recruiters merits a new category that slightly offsets this drop: firms that do Internet products and services, such as Amazon.com, Alta Vista, Doubleclick, and several e-commerce firms. This year they made up 2.3 percent of employers. Together, software and Internet firms comprised 16.5 percent of the AY2002 recruiting program.

Accomplishments

We made real progress toward our goal of serving students in all disciplines and at all stages of their education. Staff created new ways to reach students who have not historically used OCSPA and who have not been well served by on-campus recruiting. We literally went everywhere to serve students, through programs like OCSPA on the Road (workshops for undergraduates in dorms and living groups), Career Workshops for Athletes (held in the Athletic Department), presentations to the Graduate Women's group, the Black Graduate Students group, and at departmental orientations. This fall we will offer evening hours for the first time in our history.

Student use increased for all our career development services (counseling appointments, walk-ins and career workshops) this year. We attribute this to two primary factors: students' concern about the economy and our intensified outreach. Staff conducted more than 2,750 office visits with students, alumni, postdocs and others in FY2002, compared to 2,353 in FY2001 (+ 16.8 percent). Counseling appointments, 1,801, increased by 23 percent. There were 948 (+6 percent) students to use "Walk-In Hours" and 3,919 students (+11 percent) attended workshops. A majority, 70 percent, of student visits were by undergraduates and 30 percent were by graduate students. Of the 1,620 OCSPA visits by undergraduates, 581 were by freshmen, 372 by sophomores, 322 by juniors and 345 by seniors. Of the 704 office visits by graduate students, 439 were by masters students and 265 were by doctoral students. OCSPA also had 53 visits by postdocs, 338 visits by alumni, and 35 visits by employees and others.

The following tables detail this level of activity and which MIT students are using our services.

Office Visits by School

	FY02	FY01	FY00
Engineering	1,299	1,200	764
Science	585	530	429
Architecture & Planning	193	168	104
Management	138	123	230
HASS	107	103	53
LFM	2	7	-
Whittaker College	10	3	-
None indicated	135	132	-
Undeclared freshmen	281	87	44
Total	**2,750**	**2,353**	**1,624**

Workshops Offered and Student Attendance

	Workshops		Attendees	
	FY02	FY01	FY02	FY01
Basic workshops	48	42	770	477
Graduate students	10	6	178	173
Special presentations	26	20	1,098	1,290
Engineering	30	19	800	752
Science	9	12	341	340
Architecture	12	6	238	403
HASS	2	3	60	50
MGMT	4	1	230	18
DUSP	10	1	204	16
Total	**151**	**110**	**3,919**	**3,519**

We increased outreach to and programs for graduate students. Clearly there is considerable need for and interest in career planning among graduate students, and special concerns for PhDs. Many have viewed OCSPA as solely focused on undergraduates, with little to offer graduate students. This year we worked closely with the Graduate Student Council, inviting them to our staff meetings, collaborating on plans for the 2002 Fall Career Fair, and joining forces with them and the Provost's Office to offer a series of faculty presentations on various aspects of academic careers.

The first session this June drew a crowd for a candid discussion by five faculty, including Chancellor Philip Clay. Hannah Bernstein, assistant director for PhD and postdocs, introduced a summer career transition seminar, offering five sections which will serve over 70 PhDs and postdocs

by July 2002. Student feedback has been very positive and participation has been high. The assistant directors serving Architecture, Urban Planning, and Technology and Policy professional master's candidates all offered new programs tailored to these students. These include an Architecture Summer Internship Program, Speaker Series in Technology and Policy Careers, and Professional Development CD-ROM and workshops for DUSP.

In FY2003 OCSPA will reallocate staff resources to hire an assistant director for graduate programs who, with the assistant director for PhDs and postdocs, will focus on graduate students.

We worked hard to equip students for a recessionary job search, presenting special workshops and new events to help them strategize, identify potential employers, hone job search tools and skills, and maintain optimism. Assistant Director for Employer Development Jason Wall developed new opportunities through a nonprofit career fair co-sponsored with Tufts and Harvard, eFairs with Caltech (to increase west coast opportunities) and the Ivy+ schools, and our first virtual employer presentation. Staff published and contributed to articles in *The Tech* and *Tech Talk*, to provide perspective on the economy and practical advice about how to find a job in a down market.

We helped a total of 123 MIT applicants apply to medical school: 54 undergraduates, 6 graduate students and 63 alumni/ae. As usual, this number mirrored the national trend. After reaching a high of 213 in 1996—our largest applicant pool since 1988—the number of MIT applicants declined consistently, except in 2000 when it barely moved. The number went from 198 (1997) to 172 (1998) to 165 (1999) to 168 (2000). In 2001, 65 percent of MIT undergraduate applicants, 100 percent of graduate students, and 70 percent of alumni/ae were accepted. (The national acceptance rate for all applicants was 50 percent.) While both graduate and alumni/ae acceptance rates increased from 2000 (to 43 percent and 11 percent, respectively), undergraduate acceptance rate declined 16 percent. For reasons we do not fully understand, the cut-off point for MIT undergraduates' GPA and MCAT scores was much higher than in recent years. (In 1999, the lowest GPA of an MIT undergraduate accepted to medical school was 2.9. In 2000, this number was 2.7. In 2001, no MIT undergraduate was admitted with a GPA below 3.29.) The national average has stayed relatively stable, but medical school admissions offices are putting more emphasis on non-academic factors.

Premedical advising focused on strengthening communication and sense of community among advisors and students and increasing the usefulness and distribution of premedical advising information. The premedical advising team, led by assistant director Shonool Malik, created events to bring people together and share information, starting with an Advisor Appreciation Lunch in September at which President Vest and Dean Redwine acknowledged the advisors' importance to our students. This was also an occasion to collectively explore ways to improve the MIT premedical advising system. We hosted an Advisor /Advisee Mixer and an Advisor/Advisee Reception to celebrate the end of the advising cycle and students' medical school entrance. These events were very well attended and received.

New approaches were developed to make useful information available to premedical advisors and advisees, including information sessions tailored to each class, and an IAP seminar for students exploring medical and other health-related careers. Two hundred seventy-five undergraduates participated. Premedical staff created brochures that describe the application process, trends, roles and responsibilities, and OCSPA. The team collected, analyzed and interpreted applicant and admissions data from 1999 to 2001, to better inform premedical/predental advising. Staff also consulted with MIT's legal counsel to bring appropriate changes to the premedical application process and to avoid litigious situations.

Our Freshman/Alumni Summer Internship Program (F/ASIP) began its fifth year with a restructured curriculum focused on helping students develop leadership and teamwork skills. Assistant director Alisa Tongg emphasized accountability, with the goal of higher student retention and better workplace preparedness. Two hundred ninety-nine freshman attended F/ASIP information sessions and picked up applications in the fall; 94 students completed the program requirements. Undeterred by the tight job market, 74 students (79 percent, compared to 49 percent last year) found internships. This is the highest internship placement rate in F/ASIP history, reflecting the personalized coaching each student received. Students will work in 17 different states and abroad in China, Africa and the UK. F/ASIP staff had 473 student appointments and presented workshops to 956 students.

F/ASIP gained unanimous support from the Committee on Curricula to revise the structure and grading of SP.800. The change from P/F/NC to A,B, C, N/C, will allow us to reward students for their accomplishments, at the appropriate level. Because these changes are likely to produce increased demands on F/ASIP staff, participation will be limited to 75 students in FY2003.

We helped launch the School of Engineering's new Undergraduate Practice Opportunities Program (UPOP), an internship program for engineering sophomores. Staff worked extensively with UPOP, providing employer referrals, tailored programs and individual counseling sessions for students, and space, equipment and contacts for UPOP staff. These efforts contributed to UPOP's successful first year and to OCSPA's increased visibility among engineering sophomores.

We streamlined our annual Graduating Student Survey process (from collection to analysis) by converting to a web-based format. We achieved a response rate of 44 percent, 980 students, (the same response rate as in 2000) and saved many hours of staff time previously spent distributing the survey throughout the week before graduation. We anticipate more complete data from the web-based form, which was revised to be more user-friendly. Preliminary analysis shows that 32 percent (310) of respondents will attend graduate school and 61 percent (597) will begin employment.

We improved our process for mailing recommendation letters to medical schools and reduced turnover time from seven to three days.

The premed team worked with premedical council co-chairs and faculty in HST and Chemistry to revise MIT premedical subject requirements so that they correspond with medical school specifications.

OCSPA staff undertook a number of assignments on behalf of the Institute. Deborah Liverman continued a three-year appointment as a member of the planning committee for the Martin Luther King, Jr. Celebration. Tamara Menghi and Marilyn Wilson taught workshops on career and academic advising to the freshman advisors. Tamara Menghi participated in an Advising Information Group which is streamlining web resources, as part of the Discovery Project. Elizabeth Reed chaired the Council on Family and Work's Task Force on Workplace Flexibility, and served on the Council's Assessment Team which surveyed faculty and staff about quality of life issues.

Staffing Changes

Elizabeth Reed became director of OCSPA in September 2001, following Christopher Pratt's departure to Columbia University. Carole Ferrari was promoted from assistant director to associate director. Tamara Raimundi Menghi was promoted from career development counselor to preprofessional advising coordinator. Julie Cecil, career assistant, was hired for a new position of coordinator, F/ASIP and preprofessional advising. Mary Sullivan became a career development counselor, moving from the premedical team. Bonnie Walters ended a year-and-a-half stint as consultant premedical advisor. Jordan Siegel and Sarra Shubart joined the support staff, filling positions left by Heather Barry and Patricia Maguire, who went to academic departments at MIT. Ricardo Bianco, career counselor for the School of Engineering, left OCSPA to work in mental health.

Elizabeth Reed
Director

More information about the Office of Career Services and Preprofessional Advising can be found online at http://web.mit.edu/career/www/.

Edgerton Center

The Edgerton Center's mission is to uphold the legacy of Harold "Doc" Edgerton by

- being a resource center for MIT students engaged in hands-on projects, intercollegiate technical competitions, and service learning
- maintaining MIT's expertise in high-speed and scientific photography
- building ties to the broader community through our K–12 outreach program

This has been a year of major administrative and financial changes for the center. First, our administrative home shifted from EECS to DUE; then, in the spring of 2002, Esther Edgerton passed away, which affects the center's funding.

Our two new initiatives are prospering. The service learning initiative (a collaboration with the Public Service Center) is off to an excellent start. Our first year's offerings included 20 subjects in 8 departments or programs and 3 summer UROPs. This work is supported by a d'Arbeloff grant and the Massachusetts Campus Compact. This effort is led by Amy Smith of our staff and Sally Susnowitz of the Public Service Center.

The initiative to promote student teams and clubs is supported by the Stratford Fund (endowed by Ken Olsen) and our own resources. A long-standing problem has been finding space that these students can use to pursue their ambitions projects (e.g. rockets, robot submarines, and solar cars). We have now secured permanent space for the clubs in the basement of Building E60 (the old Arthur D. Little building) and the clubs are moving into their new home.

Finally, we regret to report that Esther Edgerton passed away on March 9, 2002, with services held in Belmont on March 16. We hosted a reception at the center that afternoon for the extended Edgerton family and friends, which was well attended. In keeping with the agreement that created the Edgerton Center in 1992, the Harold and Esther Edgerton Family Foundation is generously establishing a permanent endowment for the center, allowing us to continue our mission of carrying on the Edgerton legacy at MIT.

New Initiatives

Service Learning

The premise of the service learning initiative is that students learn more from a project when they know their creations will make a difference in the lives of others. Our goal is to couple service learning with the Edgerton Center's focus on hands-on education to create a range of subjects across the Institute that challenge our students to learn science or engineering while addressing problems that support the larger community. For more information see http://web.mit.edu/mitpsc/sl/.

A highlight of the year was the IDEAS (Innovation, Development, Enterprise, Action, and Service) Competition, which provided MIT students with an opportunity to nurture their creative skills by providing the financial resources necessary to implement plans and products that meet community needs. Twenty-two student teams developed designs, plans, strategies, materials, and products while working with community partners, locally and internationally. The winning project—"Pure Water for Nicaragua"—is dedicated to finding a feasible and sustainable solution for potable water accessibility in rural areas in Nicaragua. For more information see http://www.mit.edu/~ideas/.

Support for Student Clubs and Teams

The Stratford Foundation has offered generous financial support to greatly expand the center's ability to support student-initiated hands-on projects. Supported projects include:

- MIT Solar-Electric Vehicle Team
- Aconcagua Expedition (assessing quality and safety of high-altitude water sources)
- Formula SAE (formula-style auto racing)
- Microcontroller Project Lab for HS students (precursor to the Women's Technology Program)
- Project ORCA (underwater robotics)
- Project Saorise (novel delivery of neurological compounds)
- Battlebots
- US FIRST (high-school robotics)

We provide these groups with institutional recognition of their efforts, some financial support (they are expected to raise a significant portion of their support from other sources), access to a pool of common tools and resources, and (most difficult of all) space to carry out their work. We have now secured permanent space for the clubs in the basement of Building E60 (the old Arthur D. Little building), which the Institute has generously renovated. The clubs are moving into their new home, and we expect them to continue to excel (http://web.mit.edu/edgerton/student-groups.html).

Academics

Strobe Project Lab (http://web.mit.edu/6.163/www/) continues to be heavily over-subscribed, and our other regular offerings in electronics, robotics, and digital imaging are also popular. Residence-based robotics and electronics seminars in Random Hall have proven to be quite successful over the past two years, and we intend to continue offering them as long as demand continues. In addition our staff oversaw three advanced undergraduate projects for EECS students, as well as 38 UROPs for credit or pay. A listing of our fall 2002 subjects can be found online at http://web.mit.edu/edgerton/courses_f02.html.

Technical Imaging

The center is still the Institute's go-to place for high-speed imaging. Our high-speed video systems were used by eight research groups and five Institute subjects over the past year. We are about to receive a donation of a color high-speed video system from NAC Image Technology, Inc. In addition we presented a week-long summer short course on high-speed imaging which attracted 15 attendees from industry and 4 MIT students from various research groups. This subject is now in its third-year (http://web.mit.edu/Edgerton/ShortCourse.html). Our darkrooms—both digital and film—are well used by students from four subjects and by students pursuing UROPs and other hands-on projects.

Outreach

Our outreach program continues to grow, with 1,185 Cambridge students (4th through 8th grades) coming to the center for hands-on science activities. We also provide these activities to other community groups (other schools, scout groups, home schoolers, etc.). Activities offered to non-Cambridge groups brought in another 971 students, for a total of 2,156 students. Over the seven years of this program, the center has been a window into MIT for many thousands of children and adults in the larger community.

We have introduced a new outreach activity, which was developed with Professor Heidi Nepf of the Department of Civil and Environmental Engineering. Aimed at 8th graders, it provides students with the chance to observe the processes behind the spread of pollutants in groundwater through hands-on experiments. Descriptions and photographs of this activity, and the other outreach activities, can be found at http://web.mit.edu/edgerton/outreach/Activities.html.

Also, with support from Dianne Willow and Mitch Resnick of the MIT Media Lab, we are now offering an activity using programmable bricks called crickets to control Lego motors and sensors. Students create kinetic sculptures that are programmed to respond to the environment. Video clips of some student-built sculptures are at http://web.mit.edu/edgerton/outreach/ACT_SS.html.

Student Shop and Hands-on Resources for MIT students

MIT's student shop is operated by the Edgerton Center, and its manager, Fred Cote, is a member of the center's staff. The shop is located across from the Electrical Engineering and Computer Sciences buildings on Vassar Street. The shop continues to provide an important resource to MIT graduate and undergraduate students. Students can receive training at the shop, and (once trained) are able to use the shop resources for independent projects.

By hiring part-time help, we have extended the hours of operation to 52 hours a week. The shop is now open four evenings a week, and on Saturday afternoon. The new hours are tailored to fit student schedules. Our two computer controlled milling machines have been very popular additions to our equipment pool, allowing students to make much more difficult parts for projects. In all, 6,879 student hours were logged in the shop over the past 12 months. These students represented 16 departments and programs from the Schools of Engineering, Science, Architecture and Planning, and from Health Sciences and Technology.

There have been five staff changes. Tony Calogerro has returned from a medical leave to work half time. Amy Fitzgerald became our new outreach coordinator in August 2001. Felice Frankel transferred from the center to the School of Science as of July 1. Amy Banzaert joined our staff on a part-time basis for the Service Learning initiative. She will transfer to the Public Service Center as of September, where she will continue that work. Finally, we regret to report that Professor Pat Leehey, who created our digital imaging subject (SP.757) passed away in January. His subject has been taken over by his co-instructor, Ms. Therry Mislick.

J. Kim Vandiver
Director
Professor of Ocean Engineering
Dean for Undergraduate Research

Office of Minority Education

The mission of the Office of Minority Education (OME) is to provide effective academic enrichment programs to enhance matriculation, promote higher retention and greater excellence in underrepresented minority (African-American, Mexican-American, Native-American and Puerto Rican/Hispanic) students' academic and general educational achievements, and encourage their pursuit of higher degrees and professional careers.

Program Accomplishments

Project Interphase

Project Interphase (PI) is one of the programs that illustrate MIT's commitment to ensure minority students' academic success. The program admitted 58 students, approximately one-third of the first-year underrepresented minority student population. PI is a seven and a half week rigorous academic experience involving a curriculum that includes physics, calculus, chemistry, writing, physical education and a myriad of co-curricular activities.

This year OME employed an academic staff that represented the multicultural diversity of the Institute. The teaching core, with the assistance of graduate and undergraduate students, made Project Interphase a success once again. OME was fortunate to have several Project Interphase Alumni/ae from previous years to serve as tutors and office workers in the program.

Academic advancement and enrichment continue to be major goals of PI. To that end, a high percentage of the students who took the advance placement test for 18.01 received credit. Thus they were able to take more advanced calculus classes during the first semester. Several students passed Phase I of the writing requirement. In addition we observed an increase in the number of students who passed chemistry in the first semester. These positive outcomes illustrate the value and success of Project Interphase.

Seminar XL

Seminar XL is an academic enrichment program for first-year underrepresented minority and non-minority students. The Seminar XL educational model is to divide students into small interactive learning/study groups focusing on calculus, chemistry, physics, and other freshmen core courses offered during the fall and spring terms. All study groups are coordinated by XL Facilitators who are either upper-class or graduate students. Upper-class students chosen to facilitate an interactive learning group must have achieved a B or better in the subject they have been selected to tutor for the semester.

Facilitators oversee the interactive discussion of materials covered in the subject. Seminar XL utilizes an array of facilitators from a broad range of disciplines and ethnic backgrounds. The core group of facilitators represents the rich diversity of MIT community. All facilitators are interviewed, hired and trained by the associate dean/director, in conjunction with the assistant dean/assistant director. Eighty-one minority and non-minority students enrolled in Seminar XL for the fall and spring terms that covered 8.01, 8.01L, 8.01X, 8.02, 18.01, 18.02, 5.111, 5.112, 5.60, and 6.001.

Tutorial Service Room

The Office of Minority Education's Tutorial Service Room (TSR) provides tutorial service to a significant number of minority and non-minority students. The TSR is managed by a core of upper-class students who are supervised by the assistant dean/assistant director of OME. OME employed over 50 upper-class and graduate students from an array of ethnic backgrounds to tutor in over fifty courses. The associate dean/director, in conjunction with the assistant dean/assistant director, interviewed, hired and trained all tutors. All tutors' academic records were verified to make sure that they met the academic requirement of B or better in the courses they tutored.

Freshman and sophomores made up the majority of users of TSR. TSR recorded over 1,309 hours during the fall and spring semester. Women students continued to utilize TSR at a higher rate than their male counterparts.

Second Summer Program

The Second Summer Program (SSP) enriches and supports intellectual growth while allowing participants in the program to develop a keen sense of professional possibilities in science, technology and engineering. SSP embraces a strategy of professional development for underrepresented minority students through providing an array of internships in science, engineering and other technological disciplines. Forty underrepresented minority students were accepted into the Second Summer Program for the 2000–2001 academic year by participating in a variety of activities which included several orientation sessions, resume writing, and interviewing workshops. Students participated in the SSP Engineering Design Workshop taught by Professor Alexander Slocum during the Institute's Independent Activities Period. Twenty-eight students were placed with thirteen companies that were active in the Industrial Advisory Council for Minority Education (IACME) during the summer of 2001.

Industrial Advisory Council for Minority Education

The purpose of IACME is to help ensure greater retention of MIT's underrepresented minority students and higher academic achievement through active support of, and participation in, OME's mission and goals. September

11 created many challenges for the members of the council to fulfill its mission and maintain presence on the MIT campus to support minority students. Members of the council found new and creative ways to interview minority students on campus given the restrictions on travel for many recruiters. The staff of OME was able to assist students and recruiters in telephone interviews and teleconference interviews. Even though companies were restricted in travel to the campus, members of IACME still provided internships and scholarship support for underrepresented minority students.

IACME members continue to support the organizational efforts of AISES, MAES, NSBE and SHPE by both in-kind and financial support. IACME financial support resulted in over $20,000 being directed to assist professional and cultural organizations on campus.

Office of Minority Education Student Advisory Council

This council continues to provide a mechanism for minority student organizations to bring their concerns and issues to the associate dean for undergraduate education/ director of OME. The council's members maintain a leadership role in the minority and non-minority communities. They invest a great deal of effort in assisting the Office of Admissions in recruiting underrepresented minority students to come to MIT. This year several organizations held activities for students who attended Campus Preview Weekend.

Minority Scholarships

OME maintained its role as a major repository for information on internships and scholarships targeted for underrepresented minority students.

Minority Awards Banquet

OME, in conjunction with the Graduate Student Office, the Office of the President, and the Counseling and Support Services Office, hosted the Twenty-Sixth Annual Minority Awards Banquet. The keynote speaker was attorney Maria Echaveste, former deputy chief of staff in the Clinton White House.

Staff and Other Accomplishments

After conducting a national search to identify an assistant dean/assistant director, the search committee, chaired by Professor William Watson, recommended Ms. Kim Beamon, who joined the staff of the Office of Minority Education on July 22, 2001. Dean Beamon replaced Ms. Ann Davis Shaw, who left the Institute for a position in private industry.

Marlisha McDaniels and Milagros Oquendo-Morales were nominated and selected to receive a DUE Appreciation Award for their outstanding efforts and work in coordinating several activities that occurred during the fall term, IAP and February, 2002.

After a year and half of planning by the staff of the Office of Minority Education and Robert Kaynor, OME moved to its new location in Room
4-113 across from the dean for student life and the dean for undergraduate education. This is the first time OME has had such a high level of visibility.

Ms. Margarita Ascensio was hired as assistant director of OME and joined the staff of OME on May 1, 2002. Her appointment allows the office to address an unmet need of the Latino community .

Even with the events of September 11 and the decline in the economy, we were able to recruit new members for the Industrial Advisory Council for Minority Education.

OME collaborated with the Academic Resource Center to increase the number of minority faculty and administrators participating in the Traditional Freshmen Advising Program.

We strengthened our partnership with the Office of Career Services and Preprofessional Advising on numerous activities, including Project Interphase informational sessions, training of students who participated in the SSP on how to use JobTrak, and presenting information on the programs and services OME provides to students of color. In addition, the associate dean/director was asked and agreed to serve on the F/ASIP Advisory Council.

Staff members had over 400 sessions with students of color to discuss a broad range of issues ranging from academics, personal, social and professional advising.

OME worked closely with the Counseling and Support Services Office in assisting minority students who were required to withdraw by the CAP. In addition, we played a pivotal role in the re-admission of minority students who returned from either a leave of absence or a required withdrawal.

OME established a new partnership with the Teaching and Learning Laboratory. This year, Lori Breslow, director of TLL, conducted a training workshop for all tutors working in Project Interphase.

We continued to work with NASA to administer its Undergraduate Research Scholars Program at MIT. The purpose of the program is to increase the number of underrepresented minority researchers in the fields of engineering and science. MIT is one of eight colleges and universities participating in the NASA URSP Program. The other colleges and universities are Purdue, Stanford, Texas A&M, University of Alabama, University of Central Florida, University of Maryland, and University of Michigan.

OME, in conjunction with NASA, hosted its second Research in Science and Engineering (RISE) Institute, led by Professor Marty Culpepper. There are four RISE Summer Institute sites across the country: MIT, Purdue, Stanford and University of Michigan. Over 50 students from 23 different institutions nationwide participated in the second year of the Research In Science and Engineering Summer Institute. The program is designed as a research preparation initiative aimed at preparing participants for more intense future research experience. Students who participate in the program are rising sophomores at their respective colleges.

The associate dean and director provides strong leadership through his stewardship in developing the Memorandum of Understanding for the Presidential Empowering Minority in Engineering, Science and Technology to Reach for Graduate Education Consortium. The purpose of the presidential initiative is to increase the number of underrepresented minority students entering graduate schools in science, engineering, math and technology through collaboration and shared best practices. This presidential initiative involves Georgia Tech, Carnegie Mellon, University of Michigan, Spelman, Clark-Atlanta, The Board of Regents for Arizona State University, California Institute of Technology, North Carolina A&T State University, and MIT. Nine presidents across the country from the above mentioned colleges and universities have signed the MOU to make the consortium a working reality.

Leo Osgood
Associate Dean and Director

Office of the Registrar

The Office of the Registrar promotes the Institute's educational goals by conveying to the MIT community and beyond accurate, timely information and providing services related to enrollment, registration, and graduation; by implementing and enforcing academic and administrative policies related to the above; by creating, updating, preserving, and issuing academic records for past and current students and alumni/ae; by developing and communicating official subject, schedule, and curricular program information; by managing and maintaining classroom space; and by publishing in these areas.

In fulfilling its mission, the Office of the Registrar works with the faculty, Institute/faculty committees, departments, staff, and students to guide and assist in developing and modifying educational policies and procedures in accordance with Institute policy and local, state, and federal laws. The office will continue to gather, maintain, interpret, and share information—through new technologies, broadened capacities, and enhanced communications—in the areas that the Institute has entrusted to its charge.

Accomplishments

Much effort was spent this year in analyzing and implementing new faculty and administrative policies, and supporting new educational initiatives and community events. We continued to exploit the robustness of MITSIS in meeting all of the challenges within this dynamic environment.

We also intentionally focused on continual communications between our office and students, faculty and staff. In particular, this year's commencement required us to devote much time and attention in this area.

Technological highlights in partnership with SSIT:

- Piloted an online undergraduate degree audit that better displayed a student's progress to fulfilling the GIRs and units beyond. Students and advisors enthusiastically welcomed this new functionality at WebSIS.
- Analyzed, designed, and developed new processes for the implementation of ABC/NoRecord grading for freshmen.
- Developed a new format for the commencement book that increased readability and reduced cost. The book had not been altered since 1959.
- Developed, tested, and implemented the new off-campus internship tuition and rewrote the tuition assessment program.
- Developed a web-based scheduling tool that combines WebSIS and MITSIS information.

Policy work highlights:

- Worked with CUP, Academic Services, and Admissions to define new policies and procedures for Freshman Advanced Placement Credit and the new Sophomore Exploratory Subject.
- The catalog section worked with faculty committees to create 109 communication-intensive major (CI-M) subjects. This work included the review of the CI-M subjects within the context of the degree requirements. Modified the *Bulletin* degree charts to accommodate the new requirement.
- Worked with faculty and staff to create special subject arrangements to support faculty and department needs and initiatives for CMI and UPOP.
- Worked with the Cambridge-MIT Institute to develop procedures for Cambridge students studying at MIT.
- Worked with Professor Lang to enforce the prerequisites for 6.002.
- The Committee on Student Information Policy developed an education plan aimed at making administrators more aware of the Institute's Student Information Policy.

Classroom management highlights:

- Led the design effort for the complete renovation of five classrooms in Building 1, adding level IV technology to each space
- Led the effort to complete renovations of a classroom on Building 5 used primarily by the Department of Architecture
- Led the design effort for a new seminar-style classroom in Building 14N
- Led the design effort for seminar rooms 4-251 and 4-253 as a replacement for 10-280
- Provided major cosmetic improvements in Lecture Hall 6-120
- Provided new floor and fixed seating in Room 4-159 and new floor, paint, seating and video projector in Room 4-370
- Served on the Stata Center classroom design team
- In conjunction with AV, implemented an audiovisual maintenance program to support technology enhanced classrooms

Operational highlights:

- Streamlined the freshman registration process, eliminating paper forms, and improved service to students

- Eliminated the mailing of fall term grade reports, thus reducing our mailing costs
- Enhanced the online biographic form for students, thus eliminating the use of the paper form and reducing costs
- Increased the fee for transcripts from $3 to $4
- Developed new web pages for current and former students regarding enrollment and degree certification and replacement diplomas
- Worked with the Student Conflict Office to streamline procedures for the processing of dean's certification forms and improve service to students
- Worked with COC to approve 103 new undergraduate subjects, substantial changes to four degree programs (Courses 8, 10, 13, and 22), and two new minors
- Developed a new system of communicating with students and faculty regarding conflict exams

Registration

In academic year 2001–2002 student enrollment was 10,204, compared with 10,090 in 2000–2001. There were 4,220 undergraduates (4,258 the previous year) and 5,984 graduate students (5,832 the previous year). The international student population was 2,589, representing 8 percent of the undergraduate and 37.5 percent of the graduate populations. These students were citizens of 109 countries. (Students with permanent residence status are included with US citizens.)

In 2001–2002, there were 3,457 women students (1,765 undergraduate and 1,692 graduate) at the Institute, compared with 3,335 (1,755 undergraduate and 1,580 graduate) in 2000–2001. In September 2001, 428 first-year women entered MIT, representing 41 percent of the freshman class of 1,033 students.

In 2001–2002, there were, as self-reported by students, 2,834 minority students (1,987 undergraduate and 847 graduate) at the Institute, compared with 2,780 (1,984 undergraduate and 796 graduate) in 2000–2001. Minority students included 382 African Americans (non-Hispanic), 97 Native Americans, 591 Hispanic Americans, and 1,764 Asian Americans. The first-year class entering in September 2001 included 498 minority students, representing 48 percent of the class.

Degrees Awarded

Degrees awarded by the Institute in 2001–2002 included 1,187 bachelor's degrees, 1,520 master's degrees, 10 engineer's degrees, and 501 doctoral degrees—a total of 3,218 (compared with 3,238 in 2000–2001).

Personnel Changes

Lisa Rung, assistant registrar in the Schedules Office, departed after 13 years of wonderful service. Wayne Johnson was hired to replace Lisa.

Mary Callahan
Registrar

More information about the Registrar's Office can be found on the web at http://web.mit.edu/registrar/.

ROTC Programs

Air Force Reserve Officers' Training Corps

Our mission is to train leaders to be commissioned second lieutenants in the United States Air Force.

Year-end Enrollment in AFROTC as of June 2002

	Freshmen	Sophomores	Juniors	Seniors	Total
MIT	10	7	10	8	35
Harvard	2	2	2	2	8
Tufts	0	0	0	1	1
Wellesley	0	1	0	0	1
Total	**12**	**10**	**12**	**11**	**45**

Accomplishments

The academic year 2001-2002 at Detachment 365 at MIT was exceptional. The year started with a memorable New Student Orientation weekend in September 2001. We had six cadets flying on weekends at Hanscom Air Force Base (AFB). In October 2001, the detachment went on a two-day hike on the Appalachian Trail. In November 2001, we had a dining-in with former MIT graduate LTC William Shelton as the guest speaker. In November 2001, the detachment sponsored a Veterans Week Program. The week began with a tri-service POW/MIA Vigil. We also marched in the Boston Veteran's Day Parade.

In February 2002, the detachment visited Nellis AFB for a base visit. In March 2002, the detachment visited Burlington ANG Base to view F-16 operations. In April 2002, the detachment visited the National Battlefield at Gettysburg for a leadership seminar. In May 2002, the detachment went on another two-day hike on the Appalachian Trail. In June 2002, we commissioned nine MIT graduates, one Tufts graduate, and two Harvard graduates as second lieutenants.

New Initiatives

Colonel Kuconis again taught a freshman seminar, SEM130, and was a freshman advisor.

Detachment 365 along with Army and Navy ROTC developed a joint leadership seminar with the Sloan School of Management. This 3-credit seminar was taught during IAP.

Staffing Changes

Major Daniels was reassigned.

Colonel John E. Kuconis
United States Air Force

For more information about the AFROTC program, please visit our detachment web page at http://web.mit.edu/afrotc/www/.

Army Reserve Officers' Training Corps

The mission of the Army Reserve Officers' Training Corps (AROTC) is to develop, train and commission the future officer leadership for our Army by providing instruction and training in military science subjects with a focus on leadership development.

Accomplishments

The department increased enrollment by 70 percent (38 to 54) and is on track to commission 15 second lieutenants by 2005, reversing a 10-year declining enrollment trend.

Faculty/cadre accomplishments:

- Assistant professor of military science Captain Allan Wiernicki was awarded the Leo Codd Award (2nd Place) for best Army ROTC instructor in the country. Captain Wiernicki competed against 1,500 instructors from 270 colleges and universities.
- Assistant professor of military science Captain Rick Berube was awarded 2nd Place in Cadet Command's Recruiter of the Year competition. Captain Berube competed against 269 recruiting officers nationwide.
- ROTC Department senior secretary Ms. Marie Tranquillino was awarded $2,000 from MIT's Excellence Awards Program in the Working Smarter/ Getting Results category.
- MIT professor John Carroll was presented with a Department of the Army award for Civilian Patriotic Service for his extensive IAP collaboration with Sloan and ROTC.
- MIT professor Mark Spearing was presented with a Department of the Army award for Civilian Patriotic Service for support as chair of the ROTC Oversight Committee.
- MIT professor Fred Moavenzadeh was presented with the Engineer Regiment's deFleury Medal by the Chief of Engineers for his 40 years of service to engineer soldiers.

Course Offerings:

- Army ROTC cadre planned and executed the IAP leadership seminar 15.952 with Sloan's Leaders for Manufacturing Program during IAP.
- Students in 15.305 Leadership and Management received credit from the Sloan School of Management for the fourth consecutive year.

Engineer Outreach:

- Lieutenant Colonel Baker developed an engineering and science outreach initiative with member firms in the Boston chapter of the Society of American Military Engineers, as well as the Army Corps of Engineers.
- Sponsored Henderson Lecture with Army chief of engineers Lieutenant General Flowers as keynote speaker during National Engineers Week.
- Secured Army support for MIT participation in the Corps' tele-engineering distant learning program.

- Re-energized the MIT Student Chapter of the Society of American Military Engineers.
- Accepted mantle for Army Engineer Regiment's Gridley Chapter of the Army Engineer Association.

At the end of the academic year, 54 students were enrolled in our program. Of those 54 students, 17 are minority (32 percent), and 11 are women (20 percent).

Year-end Enrollment in AROTC as of June 2002

	Freshmen	Sophomores	Juniors	Seniors	Total
MIT	7	2	4	1	14
Harvard	9	12	1	2	24
Wellesley	2	2	0	1	5
Tufts	0	1	0	0	1
Other	2	2	2	0	6
Total	20	22	8	4	54

Of the fourteen enrolled MIT students, eleven are currently on scholarship. This year the Army ROTC commissioned 5 new second lieutenants, two from MIT.

Off-campus learning opportunities continued to attract cadets who volunteered for training at Fort Benning, GA (Airborne School) and Fort Bragg, NC (Troop Leadership). Participation continued to be strong in the MIT Pershing Rifles Company, a group of both ROTC and non-ROTC students dedicated to the pursuit of excellence in military leadership and tactics.

We have moved closer to bringing our two-part vision to fruition:

- To develop the best university leader-development program in the nation; honing and sharpening the leadership and management qualities of some of the most gifted young Americans who will lead our Army into the 21st century.
- To transcend institutions whereby future leaders of our Army, government, industry, business and academia carry with them our values, armed with the experience of service to nation through ROTC.

Staffing Changes

Four new faculty members have joined the department: Major Lee, Master Sergeant Haas, Staff Sergeant Sanchez and Sergeant Howell. Two faculty members have departed, Major Curran and Major Schwab. Sergeant Hiett has returned from a six-month temporary duty assignment in Europe. The PMS, LTC Baker, finishing his second year at MIT, was approved to extend his tour of duty a fourth year, through 2004.

Lt. Colonel Brian L. Baker
United States Army

More information about AROTC can be found online at http://web.mit.edu/armyrotc/.

Naval Reserve Officers' Training Corps

The mission of the Naval Reserve Officer Training Corps Program is to "develop midshipmen mentally, morally and physically and imbue them with the highest ideals of duty and loyalty, and with the core values of honor, courage and commitment in order to commission college graduates as naval officers who possess a basic professional background, are motivated toward careers in the naval service, and have a potential for future development in mind and character so as to assume the highest responsibilities of command, citizenship and government."

At the Massachusetts Institute of Technology the officers and staff assigned to the Naval Science Department are committed to ensuring that every midshipman balances his or her time and energy to realize the tremendous benefits of a MIT, Harvard or Tufts education along with the professional development opportunities afforded by the NROTC Program.

Accomplishments

Academic year 2001–2002 was most successful in many regards. Following is a summary of key accomplishments:

- Each scholarship midshipman completed a month-long cruise with a Navy ship, aviation squadron or Marine Corps unit during the summer. Many had the opportunity to serve with forward deployed units and visit foreign countries.
- Completed instruction of nine Naval Science courses of instruction. These classes are convened at 7:30 AM so as not to interfere with the academic schedules of the host and affiliate universities. These classes are monitored by the visiting professor of naval science at a frequency appropriate to ensure a high quality of instruction.
- Each semester, the battalion leadership structure changes with a formal change-of-command ceremony. The staff gives the student leadership the freedom to mold their unique legacy through the activities and training sessions they are responsible for.
- Each unit of midshipmen, from squad to the full battalion, took ownership of a particular community-service activity. The battalion assisted with feeding at the New England Shelter for the Homeless while activities of the smaller units ranged from VA hospital visits to volunteering at fundraising events throughout Cambridge.
- Other key activities include two formal balls, three military excellence competitions (Cornell, Villanova and Holy Cross), hosting a sailing regatta on the Charles River (Beaver Cup), mentoring of Junior NROTC cadets at inner city high schools.
- Commissioned 10 MIT graduates as ensigns in the Navy and second lieutenants in the Marine Corps (five

Tufts students additional).

Staffing Changes

During this academic year, two technical instructors were relieved of their duties and, amazingly, both were replaced by MIT alumni!

Lieutenant Deena Disraelly '96 recently assumed the duties of senior class advisor and navigation instructor. Deena reported from the aircraft carrier *USS George Washington* and she is most welcome as the first female technical instructor in Boston. She has proven to be a terrific mentor to the large population of female midshipmen at MIT.

Lieutenant Kelly Baker completed a master's degree program in Course 2 after earning his undergraduate degree from University of Illinois. He is the submarine force representative on the staff and reports from a Trident SSBN stationed in the Pacific Northwest. He has performed brilliantly as the naval engineering instructor.

A civil service employee was hired to serve as administrative assistant at both MIT and Boston University. Venessa Manzano is a Filipino American who graduated from Northeastern University last year. She has proven to be a tremendous asset to the organization.

The executive officer was relieved in May by Commander Gary Smilowitz, a naval aviator reporting from an exciting tour of duty in London on the Navy staff in Europe.

MIT's generous scholarship benefits offered to staff officers pursuing advanced degrees has been instrumental in maintaining the high caliber of talent.

Captain Conrad J. Donahue
United States Navy

Student Financial Services

The mission of Student Financial Services is to enable students to meet their financial obligations while ensuring access for all qualified students without regard to their financial need.

The core business functions of Students Financial Services are student accounts, financial aid, student and parent loans, and student employment. Student Financial Services is also responsible for the Student Services Center, which provides a broad range of academic, financial, and general information services to students, parents, alumni, members of the MIT community and the general public. The mission of the Student Services Center is to provide accurate, friendly, and timely service to its customers.

Accomplishments

In FY2002, tuition revenue from students totaled $286,911,076—$175,355,878 of which was graduate tuition, and $111,555,198 undergraduate tuition.

Students and their families paid late payment fees of $176,085 and MIT Monthly Payment Plan fees of $127,321.

In FY2002, 3,753, or 89 percent, of the 4,220 registered undergraduates received some type of financial aid—grant, loan, employment—from some source—institutional, federal, state, and private. The total of grants and loans to MIT undergraduates was $69,405,960, an increase of 10.5 percent from FY2002.

Sources of Undergraduate Financial Aid

Grants	MIT Grants	$38,876,858
	Federal Grants	$ 5,097,168
	State and Private Grants	$ 8,039,194
	Subtotal of Grants	$52,013,220
Student Loans	MIT Loans	$ 1,170,835
	Federal Loans	$ 7,649,589
	State and Private Loans	$0
	Subtotal of Student Loans	$ 8,820,424
Parent Loans	MIT Loans	$ 2, 218,251
	Federal Loans	$ 3,102,015
	State and Private Loans	$ 3,252,050
	Subtotal of Parent Loans	$ 8,572,316
Total Undergraduate Grants and Loans		$ 69,405,960

In FY2002, 931, or 16 percent, of the 5,984 registered graduate students received a student loan from institutional, federal, state and private sources. Total graduate students loans were $22,067,204, an increase of 47 percent from FY2001.

This growth is attributed to the introduction of a new student loan program, Sloan CitiAssist, for two-year MBA students. MIT Technology Loans to graduate students decreased 33 percent from FY2001, as expected due to the introduction of Sloan CitiAssist.

Sources of Graduate Student Loans

MIT Loans	$ 3,736,882
Federal Loans	$ 11,336,543
State and Private Loans	$ 6,993,779
Total Graduate Student Loans	**$22,067,204**

Other significant accomplishments during FY2002 include the following:

- Undergraduate student borrowing decreased 24 percent as a result of the decrease in self-help from $7,600 per student to $5,600.
- SFS in partnership with the Controller's Office, Sloan School of Management, and Citibank developed and implemented a student loan program, Sloan CitiAssist, for Sloan two-year MBA students.
- SFS in partnership with Student Services Information Technology brought up a new financial aid information system, PowerFaids.
- SFS laid the groundwork for its information technology modernization through a joint venture with Edgewater Technology—supported by Student Services Information Technology—by developing a proof-of-concept for a new MITSIS interface.
- Student Accounts reduced its accounts receivable by 54 percent from June 2001 to June 2002.
- Student Employment succeeded in meeting the requirement to spend over 7 percent of its Federal Work-Study funds on students employed in community service positions.
- Student Loans ended the year with an education loan receivable portfolio of $81,107,639 with 9,567 active borrowers.
- The financial aid staff was reorganized to provide dedicated financial aid services for three distinct groups of students—prospective undergraduates, current undergraduates, and graduate and professional students.

Student Financial Services continues to administer the MIT Educational Loan Program to faculty and staff. In FY2002 $2,328,341 was loaned to MIT faculty and staff, and $2,172,032 was collected. The year-end receivable balance for the program was $2,786,542.

Staffing

During FY2002 there were numerous staffing changes within SFS. Ten staff members left MIT, 12 were hired, and there were three internal transfers/promotions.

Staff who left Student Financial Services during the past academic year include Yolla Auguste, financial aid representative; Mary Barry, student account counselor; Jill Desjean, assistant director of financial aid; Craig Fennell, associate director of student financial services; Sarah Hernandez, student account counselor; Kimberly Huse, student services representative; Anne McCall, student services representative; and Trudy Zakin, assistant director of financial aid.

Staff who joined Student Financial Services include: Theresa Allen, business analyst; Jennifer Cooper, financial aid officer; Dwight Doherty, student account counselor; Sheherezade Essack, communications officer; Tanitia Graham, administrative assistant; Mary Ellen Grannan, student services representative; Sophya Gudelman, student services representative; Kathleen Manzolillo, student employment representative; Amanda Romero, student account counselor; Daniela Trammell, student services representative. Two staff members were with Student Financial Services for only a year—Jerry Whitlock, associate director for planning and innovation, and JoAnne Hassel, financial aid representative.

Three staff members took on new responsibilities within Student Financial Services. Heather Clang became the manager of student services; Yvonne Gittens took on responsibility for financing options and graduate students; Carmen Velez was promoted to financial aid counselor.

Two of the 10 departing staff, or 20 percent, were minority, whereas four of the 12 staff hired, or 33 percent, were minority, resulting in a more diverse SFS staff. Two of the three internal transfers/promotions were minority staff.

Elizabeth M. Hicks
Director

Student Services Information Technology

The mission of Student Services Information Technology is to provide high-quality information services support to a wide-ranging set of users within the Offices of the Dean for Undergraduate Education and the Dean for Student Life, and MIT in general.

This support focuses on the automation of business processes and information systems to provide students, faculty and administrators with timely and accurate information and support.

Accomplishments

Client-Focused

- Athletics discovery—led and successfully concluded a discovery process on how IT can support the Athletics Department's physical education and eligibility processes, and their regular and ad-hoc reporting needs.
- Communication Requirement—integrated processes to support the new Communication Requirement into the MITSIS degree audit systems. Developed an advisory messaging system to support the newly established Communication Requirement at MIT. This new system supports both the administration and advising requirements for the Communication Requirement.
- Desktop computer backup—agreement was reached with DUE and DSL that all machines would be moved to TSM Backup Service provided by MIT Information Systems.
- Desktop computer upgrade—replaced 160 machines, added 37 machines, and deployed 129 flat panel displays across DUE/DSL departments. New deployment and desktop support initiatives were begun for DSL housemasters and the Edgerton Center.
- Financial aid need analysis—implemented PowerFaids for processing financial aid awards for AY 2003. PowerFaids has replaced the old, difficult-to-maintain need analysis system written in Cobol.
- Graduate admissions—assisted Admissions staff in migrating from Macs to PCs to better support the graduate admissions application.
- Graduate admissions online application—participated in the vendor-led implementation of a web-based graduate admissions application collection and distribution system. Developed programs to load and integrate the application data to the MITSIS database and mass print the admissions applications.
- Graduate admission survey—created programs to email admitted graduate students a survey on their university choice and the factors that affected their decision; and also record and store their responses. This improved the responses, reduced the time and mailing costs and eliminated a similar system in FileMaker Pro.
- Graduate aid—implemented new functionality that allows graduate departments to process graduate awards in bulk by using departmental custom templates.
- Graduate student tuition—working with the provost, modified the tuition process to accommodate a special rate of 35 percent of regular tuition for graduate students taking an off-campus internship subject starting in summer 2002.
- International Students Office redesign and integration—designed, developed and deployed a system to automate the International Students Office's business processes and data in a secure platform. Integrated ISO processes and data with Admissions, Registrar, Financial Aid and Budgeting records and processing in MITSIS, streamlining processes and eliminating duplicate effort.
- IP address billing—redistributed IP Billing across all DUE/DSL departments.
- Mock disaster recovery—the SSIT Desktop Support Team and Student Financial Services Team participated in a successful mock disaster recovery drill for Student Financial Services
- Move support—coordinated IT-related aspects of moves for the Office of Minority Education, DUE Administration, DSL Administration, Student Conflict Resolution and Discipline and the Teaching and Learning Lab.
- Residential Life / Student Life Programs—two new dormitories, Sidney & Pacific, housing 749 students, and Simmons, housing 347 students, will open in fall 2002. Defined these buildings and rooms in MITSIS, and simplified rate structures for many other existing dorms.
- Room schedules analysis—created a system to provide web-enabled reporting and analysis of classroom usage by subject and term for the MIT Schedules office.
- Special students integration—enhanced the graduate admissions application so that special students can be entered by the Graduate Admissions Office, eliminating the need to have data transferred from the freshmen admissions database to MITSIS and providing full functionality similar to the admission of graduate students.

- SIS evolution—analyzed the state of MIT's Student Information System (SIS) and developed a high-level plan to evolve work processes and technology.
- Visiting students integration—integrated visiting students' admissions data entry into the graduate admission application. Visiting student data is collected in a central database for the first time at MIT, supporting better tracking of students and providing better integration of ISO and MITSIS systems.
- WebSIS degree audit report—to support advising at MIT, a detailed degree audit report was developed for WebSIS. This report displays a student's GIRs, the subjects taken to fulfill different requirements, and all missing requirements. This report is available on the web to both students and their advisors.

SSIT-Focused

- Academic Services Support Team—formed the Academic Services Support Team to centralize support issues that occur on a daily basis for Academic Services. Because the needs of Academic Services are extensive, the formation of this support team will allow the development team more time to focus on new development projects.
- Athletics Department search committee—as a member of the search committee, assisted in the hiring process related to the technical specialist position.
- Development environment—implemented individual project environments for development; the ABC/NR project is a pilot.
- Infrastructure Team—launched a new team with responsibility for all infrastructure activities, including project support, external support, data feed support, account support, knowledge management, security, technology platform, and infrastructure hardware.
- Mac OS X Discovery Team—as a member of the MIT Information Systems Discovery Team, provided a non-I/S perspective in developing recommendations for rolling out Mac OS X to the MIT community.
- Methodology—drafted standards for all aspects of SSIT projects, including architecture, development methodology, and tools.
- MITSIS migration—successfully migrated the MITSIS application environment and SIS database to a new operating system and hardware platform, dramatically improving system response.
- Network printing—implemented network printing on MITSIS for local printing and IBM-format printing.
- Quality assurance process—instituted a formal QA process for high-impact production issues. Wrote and disseminated two major incident reports.
- Space—after a year of nomadic temporary spaces, the SSIT Desktop Support Team finally settled into Room 12-172.
- System security—solved security problems and implemented long-term solutions by eliminating privileged personal accounts on Windows server, resolving security vulnerabilities in WebSIS, securing system connections, supporting PGP 6.5.8 encrypted data feeds, and surveying SSIT developers about their security needs.
- Training—managed training in Java technology for SSIT development staff. This included defining training needs, working with the vendor to customize training, and following up with developers. Maintained technical currency of SSIT desktop computer support staff with numerous formal training sessions.

Staffing Changes

A new position was created and part-time administrative assistant Cynthia Campbell was hired. With Joe Welch, technical assistant V, transferring to MIT Information Systems, the two technical assistant positions were re-evaluated and upgraded to consultant I. As a result, Riccardo Cosmey was promoted. Joe De Vito was hired as a consultant I to replace Joe Welch.

The implementation of the Consultant Migration Plan (migrating away from utilizing contract analyst/programmers for ongoing work) was completed. Kent Dorsey, infrastructure team leader; Bin Zhou, analyst programmer III; Brendan Gaul, network analyst programmer; and Deepali Sinha, analyst programmer III were hired.

As a result of the formation of the Academic Services Support Team, Andrea Collins was promoted to analyst programmer III and is the leader of this new team. Separately, Leonard Lu was promoted to analyst programmer II.

Robert Rippcondi
Director

Teaching and Learning Laboratory

The Teaching and Learning Laboratory (TLL) was founded in 1997 as a resource for faculty, administrators, and students who share a desire to improve teaching and learning at MIT. Its goals are to strengthen the quality of instruction at the Institute; further an understanding of the learning process, particularly in science and engineering; and provide support for the creation and assessment of innovative educational technologies, curricula, and instructional methods.

In AY2002 TLL continued to expand its work in the assessment and evaluation of educational initiatives at the Institute. During the year TLL staff members or consultants engaged by TLL have been involved in fifteen separate studies. We are just now at the point where the data from those studies are starting to provide us with the insights that will help guide further improvements in undergraduate education. In addition, we have maintained the programs and services we provide to faculty and teaching assistants for instructional support. Finally, we are beginning to reach the wider educational community through conference papers, invited talks, and publications.

As described above, TLL has three broad, yet interrelated, functions: instructional support, assessment and evaluation, and research. TLL's accomplishments in these three areas are detailed below.

Instructional Support

TLL has continued to offer the services and programs in instructional support that it has developed over the last several years. These include the Class Videotaping and Consulting Program, departmental workshops, consultations with individual faculty and departmental committees, microteaching workshops, orientations for new faculty and teaching assistants, the IAP series "Better Teaching @ MIT," and Dr. Breslow's "Teach Talk" column in the MIT Faculty Newsletter.

Specifically:

- Twenty workshops for faculty, TAs, or students were designed and facilitated—for example, workshops on the fundamentals of assessment and evaluation; teamwork workshops for classes in Courses 3, 6, and 16; and workshops on teaching for instructors working in the MITE²S, MITE²S Seed Academy, and Project Interphase programs.
- Twelve consultations were conducted, including four reviews of teaching videotapes; discussions about pedagogy; and information on K-12 outreach (e.g., with Katherine Flanigan and Irene Porro of the Physics Department).
- The IAP "Better Teaching @ MIT" series of six workshops attracted approximately 60 participants in the week it was offered.
- Dr. Breslow has been working with Julie Greenberg and Mark D'Avila of HST to develop an instructional model for instructors in higher education entitled "Strategic Teaching." This model will be the basis for HST workshops in the fall semester.
- Dr. Breslow taught "Teaching College-Level Science" (5.95) in the spring semester.

TLL staff members were also responsible for the following assessment and evaluation efforts:

- Dr. Newman organized the A&E Brownbag Lunch Series, designed to bring A&E experts from across campus together to discuss research designs, report findings, and brainstorm.
- Dr. Breslow is participating in ongoing discussions to redesign the process and forms used in Institute-wide subject evaluation.
- Dr. Lipson designed an online survey for the SDM program.
- TLL staff provided twenty consultations on assessment and evaluation to MIT faculty, students, and staff.
- Dr. Newman is a member of the assessment subcommittee of VaNTH, an NSF-sponsored ERC of which HST in one of the five lead sites.
- Through the efforts of Ms. Tervalon, four MIT undergraduates had UROPs in TLL. Ms. Tervalon conducted an educational research training workshop for these students and continues to supervise our UROPs.

Research

Dr. Breslow is working on two projects related to the study of interdisciplinary education: the first will use HST as a case study (as part of this work she is supervising the doctoral dissertation of a student from Boston College); the second is an NSF-funded study to look at interdisciplinary research and education in the area of product development.

Dr. Newman continues his longitudinal study of the intellectual growth of college students at Allegheny College.

Ms. Tervalon did research this spring on content analysis in order to adapt that methodology to the content analysis of the 8.224 discussion board. To our knowledge, this will be the first study of this kind.

Assessment and Evaluation Activities

Subject or Project	Scope of Investigation	Status of the Study
3.21	Online survey to assess student satisfaction with the teamwork component of the subject	Data to be analyzed
6.001	Experimental study, including creation and refinement of an end-of-the semester survey; comparative investigation of conceptual and algorithmic understanding gained through either live or online presentations; selection and administration of standardized instruments	Analyzing data
6.555	Creation of a study design and grading rubric to compare historical and experimental use of a problem-based pedagogy	Completed
8.224	Assessment of an experiment to enroll off-campus alumni along with undergraduates in a physics subject; project entailed a content analysis of the discussion board used during the semester	Qualitative report complete; content analysis to begin 8/1/02
18.03	Assessment of the introduction of groupwork into 18.03 recitations through classroom observation, focus groups, and surveys	Analyzing data
CMI Undergraduate Exchange	Investigation of cultural, personal, and educational impact of undergraduate exchange by developing and facilitating a faculty workshop, conducting student interviews, administering standardized instruments	Analyzing data
COFHE Spring 2002 Senior Survey	Online survey to assess seniors' attitudes and satisfaction with the MIT undergraduate experience	Data to be analyzed
College Student Experiences Questionnaire	Online survey examined student experiences of campus life and the campus environment	Completed
Concourse, ESG, ISP	Statistical analysis of enrollment data	Completed
Educational Benchmarking, Inc. 2001 Senior Survey	Assessment of the attitudes and experiences of MIT seniors who majored in engineering for fall 2001 ABET Accreditation Review	Completed
MetaMedia/ Shakespeare Video Annotation	Investigation into the use of online tools to enhance communication skills.	Analyzing data
Mission 2004–2005	Assessment of a problem- and teamwork-based freshman subject through the use of classroom observation, surveys, focus groups, interviews	Mission 2004 report complete; Mission 2005 preliminary report complete; expanded statistical report for Mission 2005 to follow
PIVoT	Analysis of use of a multimedia, web-based learning environment for Newtonian physics	Report completed
Residence-based Advising	Analysis of a program that locates freshman associate advisors and faculty advisors within the residence halls; 2000–2001 program in McCormick Hall; 2001–2002 in McCormick Hall and Next House	2000–2001 report complete; analysis of data for 2001–2002 to begin 7/8/2002
TEAL Classroom	Observed classes conducted in 26-152 in order to assess the room's functionality and make recommendations for a second TEAL-like classroom	Report completed

Four UROP students, under TLL staff supervision, did a literature review of the research on educational technology as it relates to our three research streams (i.e., the impact of educational technology on conceptual learning, student interaction and engagement, and resource allocation).

Staff Changes

In January 2002, Ms. Rosanne Swire resigned from TLL to pursue a career in graphic design. In August, Ms. MeiLin Chan will join TLL as data coordinator. In the interim, we have been helped enormously by Mr. Michael Simmons.

Lori Breslow

Director

Dean for Student Life

As Dickens wrote, "It was the best of times, it was the worst of times." The academic year opened full of hope and promise but before the campus had even had time to settle into the rhythm of its annual fall opening, external events overtook us and we were quickly diverted from our planned goals and activities to address the issues related to September 11. While I am sure that other sections of this report will focus in greater detail on this event and fallout, I am proud to say that the Division of Student Life (DSL) staff, from chaplains to deans, residence life staff to campus activities staff, rose to the occasion and performed well above and beyond their normal routines to address the myriad issues relating to the incident and its aftermath.

If there can be anything positive that can be said it is that perhaps, like no other time in its history, the MIT community came together, shared, worked, mourned, and moved forward together. We stood up to protect all the members of our community and it was gratifying to see especially how our larger community rallied behind our Muslim community.

Despite all this, life does and has gone on and even a quick perusal of this year's annual report is testimony to the hard and dedicated work of the entire DSL staff. We are proud indeed of our accomplishments, and they are many.

We finished the year with a remarkable proposal for a total overhaul of our campus dining program, with much help and input from the Campus Dining Board.

We completed plans and hired staff accordingly to open our three new buildings during the coming year: the Zesiger Center for Sports and Fitness, Simmons Hall, and the Sidney-Pacific Residence.

We had two successful visiting committee visits: DSL and DAPER (Department of Athletics, Physical Education, and Recreation, formerly known as Athletics).

We were gratified by the significant response we received from the Institute for the DSL budget request, resulting among other things in a $400,000 increase to the budgets of various student groups and activities, as well as the addition of a staff person to work with and advise student groups. Furthermore, a three-year financial commitment was made to the FSILGs to help in the transition of all freshmen living on campus.

We continued our comprehensive staff development program, with targeted programs on everything from hiring processes, progressive discipline, and affirmative action programs, to using our new centralized performance processes.

We reorganized the Office of Student Conflict Resolution and Discipline and developed new protocols and procedures associated with its work.

We developed a new mission and focus for the Campus Activities Complex, and CAC provided support to 12,580 events, for more than 600,000 people.

We established a new Office of Community Development and Substance Abuse Programs, and hired Dr. Danny Trujillo as its first director.

We refined our procedures for voluntary withdrawals and readmission processes.

We carried out a very active maintenance and renovation program in our residence halls, and developed a new housing assignment lottery system.

Our Residence Life Associates program had a very successful first year, providing help and support to our housemasters, GRTs, and residence hall students.

Our Public Service Center continued to grow and expand, providing MIT students with the opportunity to work in a variety of settings, providing services not only to Cambridge and Boston but even nationally and internationally.

Our Student Activities Office expanded its outreach to student groups, providing guidance and leadership to an ever-increasing number of student leaders and student groups.

The FSILGs received a lot of support and attention as they began to prepare for the shift of all freshmen living on campus. They redesigned their Rush (recruitment) programs for the coming year and began to work on how to use the program support monies from the Institute during this transition.

All in all, it was a most successful and productive year.

Larry G. Benedict
Dean for Student Life

Administrative Services

Administrative Services supports the mission and strategic objectives of the Division of Student Life by working collaboratively with the reporting units within the division to enable them to deliver effective programs and services to the MIT community, particularly to students.

Context

Administrative Services reports directly to Dean Benedict and is led by Laura Capone, director of organizational performance and human resources and Deb Fairchild, director of finance and space administration. The Administrative Services group is comprised of a team who facilitates and/or provides for the following functions and services to be delivered within DSL: budget and finance,

human resources, information technology, organizational development and performance, and space administration.

In FY2002, Administrative Services provided the means for significant progress toward sustainable systemic changes and business results described in the sections that follow.

FY2002 Accomplishments

Building the Administrative Services Team involved centralizing financial services and hiring to fill open positions, including two financial administrators and an administrative assistant. Administrative Services also reclassified the support staff position in HR to an administrative-staff-level HR coordinator, in order to facilitate the volume of transactional work associated with the centralized HR processes in DSL. In addition, to complete the team, a second administrative assistant was transferred from Housing to expand the support for central financial processes in DSL.

Budget and Finance

Administrative Services brought together a financial team comprised of staff representation from each DSL department to create a shared understanding and unified approach to budget and finance across the division. The formation of the team was a critical prerequisite to the successful implementation of an all-funds budget in DSL.

Administrative Services, in collaboration with the Controller's Accounting Office and the Budget Office, also led the development of new financial statements for DSL departments. These reports include income statements and balance sheets for each department in DSL and are intended to improve understanding about the DSL financial position and support resource allocation decisions.

The financial arm of Administrative Services has also begun to work with the Graduate Student Council on a review and recalibration of graduate student rents. This work will continue through the summer and culminate in recommendations for the FY2004 budget process.

DSL Approach to Budget Development Process

The divisional approach to budget development in DSL continued to evolve in FY2003. In this process, the department heads work together to set priorities at the divisional level. This process, which requires department heads to focus on organizational interests ahead of departmental ones, provided a common thematic framework for evaluating requests for new programs and initiatives.

Centralized Staff Performance Review and Salary Distribution Process

At the request of department heads, this process involved standardization of formulas for allocating merit increases, a central pool for distribution, and overall maximization of resources. The centralized system is a work in progress and will continue to evolve over the coming years. The new process applied to all staffing categories with the exception of service staff.

Human Resources

Professional Development Group

DSL completed its second year of performance development sessions for department heads, managers and supervisors. This year, more than twelve presentations, training sessions and workshops have been conducted. DSL regularly delivers relevant professional development sessions for leaders, supervisors and managers. This year's program offered an integrated approach involving operational and programmatic opportunities for more than 30 staff per session.

The programmatic opportunities for all professional staff this year included a day-long series of presentations led by Dr. Margaret Barr, who conducted presentations on "Dealing with New Realities," "Balancing Life and Career," "Student Affairs Career Opportunities for New Professionals," and a dialog session for DSL leadership.

Administrative/Operational sessions included:

- Introduction to new HR services with an overview of MIT's affirmative action policies and processes and other associated dimensions
- Roundtable discussions/presentations on effective hiring practices and processes, performance management and evaluation, and progressive discipline were conducted in FY2002
- Training in Microsoft Project Software and a Project Management Workshop were also scheduled for administrative and support staff in FY2002
- An overview of DSL's Affirmative Action Plan and an initial discussion regarding strategic planning for accomplishing affirmative action goals for the coming year was presented
- Communicating the results of the new centralized performance process with associated lessons learned and next steps

Plans are underway to involve more levels of staff in FY2003 discussions and presentations focused on successful performance and the performance review process in DSL.

Support Staff Advisory Committee

DSL also established the Support Staff Advisory Committee (SSAC) in the fall of 2001 to provide focused attention on learning and growth opportunities for support staff.

The mission of SSAC is threefold: to foster a sense of community among the DSL support staff; to share resources and strengthen communication; and to provide professional development and growth opportunities whenever possible. SSAC is sponsored by the director of organizational performance and HR in DSL and is chaired by the HR coordinator. Committee membership is composed of support staff from each DSL department.

Support staff opportunities this year included a luncheon with a presentation by Ombudsperson Toni Robinson on Balancing Work and Life, and a Career Development Workshop presented by Barbara Peacock-Coady, manager of careers planning at MIT. The first SSAC Newsletter devoted to issues of the DSL support staff was released this year as well.

Special Events Committee

The DSL Special Events Committee was established in FY2001 as a critical piece of an overall strategy for building a sense of community within DSL. The committee is comprised of staff from each of the DSL departments. The committee collects feedback and reviews lessons learned following each event so that the organization can exceed staff expectations for a quality event.

In FY2002 this committee focused on the following division-wide special events:

- Annual breakfast: Over 150 staff attend DSL's fall breakfast, which consists of the dean's introduction to the fall term, distribution of a DSL publication which includes the DSL mission, accomplishments for the prior year, and goals for the coming year. This event also offers a gift/symbol for staff with a DSL logo embossed. Staff feedback implies that this event is successful and helps to provide them with a broader view of what is happening across DSL and creates an opportunity for community building and collegiality.
- Off-site holiday function: The first off-site holiday function was realized this year. The feedback from those in attendance was extremely favorable. The holiday function continues to evolve based on feedback received by the Special Events Committee.
- Staff Appreciation Awards Design Contest: Administrative Services facilitated a Staff Appreciation Awards Design Contest in which DSL staff worked in teams to compete in a contest that would result in the selection of an appreciation awards process to be implemented in FY2003. The contest was highly successful and resulted in the group integrating ideas from each of the designs presented and coming up with a shared idea so that all were winners of the contest. The new design will be implemented in July 2002 and administered by Administrative Services.

Information Technology

DSL has also implemented a divisional approach to setting priorities for information technology. To support these priorities, Administrative Services facilitated identification of resources from a variety of sources, including MIT Information Systems, Student Services Information Technology and external consultants. Projects are currently underway to improve basic services in the Department of Athletics, Physical Education and Recreation, Housing and Student Life Programs.

Organizational Development and Performance

Department of Athletics, Physical Education and Recreation

Administrative Services facilitated the development of behavioral competency models for hiring new positions, as well as leading the development of generic models to be integrated into a new performance management system scheduled for pilot in FY2003. In addition, Administrative Services led a series of discovery processes in customer service areas which led to more effective communication and the development of agreements, project plans and new initiatives geared to improve the service environment.

Concurrent with this work, Administrative Services collected issues from the varsity sports coaches to identify performance themes for the department head which will inform the development of project plans for improved effectiveness in administrative and service areas.

Campus Activities Complex

Administrative Services worked collaboratively with the Campus Activities Complex (CAC) to identify the need as well as the appropriate support for the development of a new mission statement and the facilitation of a department-wide understanding of how resource requests directly link to the area mission. This work led CAC to work with Student Life Programs to create a shared understanding of the role of each office in relation to student programming. CAC also developed a customer service training program for CAC staff in direct relation to the critical role of staff vis-à-vis the mission. Plans to assist the department head in a targeted effort to focus on organizational structure and related service delivery for the coming year are underway.

Student Conflict Resolution and Discipline

Administrative Services identified consultants to work collaboratively with DSL staff and other MIT stakeholders to map the Student Conflict Resolution and Discipline process, establish protocol for the Committee on Discipline and DSL working relationship, develop a position description and search plan for a new associate dean, assess areas of potential risk to the institution, and identify areas of redundancy. A search committee has been formed and the search for the new associate dean is underway.

Space Administration

Space was renovated on the fifth floor of the Student Center allowing the DSL Administrative Services team and the Office of Campus Dining, together with staff from the Controllers Accounting Office who support housing and dining accounting, to work in close proximity. Administrative Services also organized a space committee for DSL. This group developed divisional space priorities for FY2003 and is now working to develop a DSL-wide space vision.

Business planning for the new graduate residence hall at Sidney and Pacific, the new undergraduate residence Simmons Hall, and the Zesiger Center for Sports and Fitness has been a major focus during the past year.

Laura Capone, Director of Organizational Performance and Human Resources
Deborah L. Fairchild, Director of Finance and Space Administration

Office of the Senior Associate Dean

The year was on the one hand marked by tragedy and on the other by the absence of tragedy. September 11 overshadowed everything else during the opening days of the school term. The Institute drew on diverse resources and experienced a strong communal pull that was unprecedented. The results of recent efforts to draw our chaplains closer to the center of the Institute paid dividends as MIT turned to the chaplaincy for a variety of needs in the days after September 11. Father Paul Reynolds recounts their good work in his report on the Board of Chaplains.

Building on the new sense of confidence in relationships after September, conversations between Jews and Muslims continued and this spring a new proposal for shared dining emerged. In addition the Muslim community reached out to the wider community in a very successful program designed to educate non-Muslims about Islam. The program concluded in early December. As a result of diverse efforts within our community, we did not have incidents of conflict following the events of September 11.

Board of Chaplains

During AY2002 the chaplains were involved in Institute-wide events such as orientation, academic advising, wellness fair, and IAP, just to name a few. Increased interaction with Residential Life, house masters, and numerous others has helped to make the Office of Student Conflict Resolution and Discipline feel integrated as a part of the Division of Student Life and the MIT community.

The Board of Chaplains sponsored seminars each semester this past year. In the spring semester the board sponsored an interfaith forum on faith issues surrounding stem cell research. Representative chaplains from different faiths shared thoughts, fielded questions and led discussions with students from many faith backgrounds.

In the fall semester world-renowned author and interfaith expert Karen Armstrong was a featured guest. Karen spoke to a large audience stressing similarities (not just differences) shared by some of the world's major faiths. This event was particularly appropriate and timely following the events of September 11.

The events of September 11 provided the impetus for much of our work as chaplains this past year. The board initiated and led a prayer service on the steps of the student center the evening of the 11th. Chaplains took active part in the all-Institute gathering in Killian Court. Chaplains helped create and lead a memorial service dedicating the "memorial wall" created at the wall of the chapel. Most importantly, beginning the hour the tragedy happened, chaplains provided a prayerful, meditative presence in the chapel. Chaplains were available for consultation and counseling in Building W11 during the darkest hours, and in the months that followed.

The Board of Chaplains takes pride in our contributions to the MIT community this past year. Sixteen chaplains and associate chaplains are part of our board, representing many of the world's religions. With the support of the ODSL, the heart of the Board of Chaplains' work is to foster communities of students that are both social and spiritual/religious in nature. Our work as individuals and as a group has been immensely successful and fulfilling. Students with almost any background or yearning can find a chaplain and group that fits their interests, heritage, and needs. The chaplains offer a wide variety of religious and spiritual and social services in the MIT Chapel, Building W11, and other places around campus. Our efforts help countless MIT students feel more at home during their years here. Being available and welcoming is our hallmark. Community fostering is our hope.

Office of Student Conflict Resolution and Discipline

The Office of Student Conflict Resolution and Discipline provides staff support to the faculty Committee on Discipline (COD). COD held nine hearings in 2001–2002. Besides administrative assistance to COD, staff provide support and guidance to complainants and to students and their advisors.

Accomplishments

There were three personal misconduct matters heard not by COD but by Dean's Office panels this year. The office convenes the panels from a pool of available members, provides administrative support to the panels, and offers guidance to the parties as in COD cases. Sanctions imposed by the panels included probation, Institute service, and a recommendation to the president of suspension.

Administrative staff handled 91 minor personal misconduct matters. The offenses included underage possession

of alcohol, theft, harassment, disorderly conduct, and accessing roofs or other prohibited areas. Standard sanctions ranged from verbal or written warnings to fines and orders to stay away from certain people or places. More creative sanctions required the students to present workshops on ethical or safety issues and to write papers about what they had learned.

The databases for cases handled by COD and for discipline matters were consolidated into one this year, allowing more efficient record keeping. The consolidation allowed staff to notify a professor who was considering whether or not to bring an academic misconduct case against a student that the student did have a prior offense, resulting in a formal complaint and hearing, instead of just a written warning.

Mediation@MIT trained 16 new mediators and provided training in conflict resolution in living groups, academic classes, and staff in-service trainings.

The office has grown from several administrative changes. Two previously independent offices were consolidated, resulting in improved efficiency and expanded capability.

Robert M. Randolph
Senior Associate Dean

Department of Athletics, Physical Education and Recreation

The mission of the Department of Athletics, Physical Education and Recreation (DAPER) is to bring students, faculty, and staff together in educational activities that promote healthy lifestyles, enhance a sense of community, foster growth in leadership and teamwork skills, and encourage the pursuit of excellence.

Strategic Objectives Audit

A committee formed by the department completed work on the strategic plan authorized by the 2000 Visiting Committee and former chancellor Larry Bacow. Implementation of the plan has begun with the fulfillment of several initiatives set forth in the plan.

The department planned for and hosted its biannual Visiting Committee meetings on April 30 and May 1. The report of this committee to senior administration and the MIT Corporation indicated strong support for the initiatives undertaken and the progress made in many areas since its last visit.

In summary, the Visiting Committee appreciated and commended the administration for its support in making the Zesiger Center a reality and for refurbishing many older facilities; the smooth transition between ODSUE and the Division of Student Life and all those who made it work; the intense effort that went into the formulation of the strategic plan; the intentional, collaborative, and open style of our new department head; the patience that resulted in a memorandum of understanding with regard to women's crew.

Construction of the Zesiger Sports and Fitness Center has continued throughout the year with scheduled occupancy in September 2002. Renovations to the physical plant continued with the completed reconstruction of the Steinbrenner Track, replacement of the wood floor in Rockwell Cage, installation of a safety/security divider wall in du Pont Gymnasium, renewal of the main offices in Room W32-109, and the striking of an agreement for a resodding program for Briggs Fields. We have also come up with a design for an installation of a card access system for Steinbrenner Stadium and Track.

Two key decisions were made in the area of facilities management. MIT has hired an outside company, Health Fitness Corporation, to operate and maintain the Zesiger Center. Additionally the Athletics Zone facilities team will be transferred to the supervision of DAPER on July 1, 2002.

A revamped varsity athletics scheduling system and procedure was implemented at the request of the coaching staff. A measurement process for assessing and increasing its effectiveness is ongoing.

A NCAA Divisional reclassification process was started for the Women's Rowing program. Once complete, the MIT oarswomen will enjoy practice and competition opportunities that will legitimize their history of competing at the Division I level.

A Student Athlete Advisory Committee was implemented on a formal basis. The committee, mandated by the National Collegiate Athletic Association, has significantly improved communication between varsity athletes and DAPER administration.

Due to ongoing construction throughout the campus, but most significantly that of the Zesiger Center, DAPER was unable to host as many town/gown functions as in previous years. A moratorium on intercollegiate varsity special events had an adverse affect on the number of town/gown functions. DAPER, nonetheless, continued to offer what facilities it could to the MIT community, and hosted over 40 events. A total of over 13,100 reservations were made for DAPER facilities throughout the course of the year (this total does not include recreational squash, tennis, volleyball, badminton, and basketball). It is anticipated that with the opening of the Zesiger Center the number of town/gown, intercollegiate varsity, and MIT community events hosted in DAPER facilities will increase to an unprecedented level.

Staffing Changes

Dr. Lynn Couturier was named director of physical education. Thomas Cronan was hired as athletic training coordinator. Carol Elder was named to the newly created post of information technology specialist. Amy Heinl was hired as manager of facilities and operations. Maureen Kelly was named operations supervisor.

Among the support staff, Ron Hopkins replaced Greg Algarin and Andrea Kosewski replaced Heather Crooke as administrative assistants in the

business office. Suzanne Rommelfanger was named the administrative assistant in the Office of the Department Head/Director. Cheryl Eccles moved into a newly created position as support to the assistant director of athletics and our coaching staff. C.J. Azubuine, Tara Israelson, Aubrey Ramage-Lay, Erica Scoppettuolo, Willis Negron, and Phil Wickens were named service assistants.

Among the coaching staff, heavyweight crew coach Gordon Hamilton and women's tennis coach Carol Matsuzaki '96 were elevated from part-time to full-time faculty/coach status. Women's crew coach Sue Lindholm was elevated from an interim position to full faculty/coach status. Mary Ellen McLaughlin resigned as men and women's swimming coach. Among part-time coaches, Lisa Naas replaced Marion Jones for softball, Tom Layte moved from interim to part-time coach of wrestling, and Jerry Molloy took

over from Roy Horsey in rifle. Also Jimmy Burke replaced Bruce Chalas as golf coach, Todd Dumond took over from Jon Shefftz as alpine ski coach, and Derek Southwell accepted a one-year appointment as nordic ski coach. Katja Pashkevitch, on leave of absence, will not to return as head coach of women's ice hockey.

Financial Services

Distribution of athletic cards remained consistent with recent years. A total of 7,850 cards (number includes locker sales) were distributed through either sales or student tuition.

DAPER Business Office working with the Stillwater Accounting Group developed a new method of tracking expenditures. The new system will allow for a more complete and accurate financial picture of all DAPER programs. In addition, the Filemaker data base system underwent significant modification to improve the department's ability to track and reconcile varsity sports expenditures.

A "full cost/all funds" budgeting system was implemented across all department accounts making reporting clearer and more comprehensive. It allows our staff to understand and view program costs in their entirety.

A financial risk assessment audit was conducted by Tony Dowgiewicz of Jefferson Wells International under the direction of MIT's Deborah Fisher, Office of the Executive Vice President, Internal Audit Division. Mr.

Dowgiewicz's report indicated that the financial controls put in place since the last audit were compliant with the expectations of MIT.

Sports Medicine

DAPER has taken proactive steps toward initiatives designed to enhance professional development, improve patient/client satisfaction, build stronger links with the Medical Department, and define how the sports medicine unit can best serve the needs of those actively involved in the varsity, club, intramural, and physical education programs.

Physical Education

This is the second consecutive year enrollment has decreased. Registrations for AY2002 were down to 5,600 from 6,541 in AY2001. In an effort to address the decrease in enrollment, an information technology discovery process was undertaken to revise the physical education online registration system. Work on this project will continue through FY2003. The existing Physical Education Lottery system will be supplanted by a system for online, real-time registration for physical education classes.

The Physical Education Program's faculty and coaches have been engaged in a curriculum development project this year and successfully completed a program mission statement and program goals. Curriculum work will continue next year. The faculty and coaches also participated in a workshop related to pedagogy and curriculum. The group eagerly anticipates the opening of the Zesiger Center this fall as it will present numerous opportunities for increased programming.

Intramurals and Club Sports

Roller hockey was added to the intramural offerings this year. Intramural participation increased 5.5 percent as 10,885 students exhibited their loyalties in competing for their dormitory floors or fraternity houses. This is the second consecutive year of increased participation in the program.

Over the past several years DAPER has supported 46 club programs, and in AY2002 added both team handball and triathlon for a total of 48. The club sports program consistently serves over 800 members of the MIT community. DAPER's collaborative efforts with DSL have generated

much needed support, including additional revenue ($60,000) to enhance the quality of the club sports program. A Club Sports Council was formed to assist in the direction of club sports. A five-person executive board was elected and will play a major role in the overall leadership and management of the program.

Student-Athlete Accomplishments

The breadth of outstanding performances by our student-athletes are too great in number to comprehensively mention in this document. Highlights of AY2002, however, are as follows:

- Caroline M. Purcell '02 won a National Collegiate Athletic Association Postgraduate Scholarship, and was the winner of the George Cointe Sportsmanship Award at the Intercollegiate Fencing Association championships.
- 882 students participated in 41 varsity sports programs
- Five student-athletes named Verizon Academic All-America, eleven student-athletes named Verizon Academic All-District
- 18 student-athletes named All-America, the second highest number ever in a single year
- Men's cross country and men's tennis qualified for the NCAA Division III championships
- Women's soccer and women's volleyball qualified for Eastern College Athletic Conference New England Division III tournaments

- Women's indoor track and field finished 10th at the NCAA Division III championships for its highest finish ever. Men's indoor track and field finished 13th.
- Men's and women's fencing were both the New England collegiate champions and were champions of the Northeast Fencing Conference
- New England Women's and Men's Athletic Conference champions: men's cross country, women's cross country, men's swimming, women's tennis, men's tennis, men's outdoor track and field
- Women's pistol team had an undefeated regular season and won the national collegiate championship in air pistol.
- Women's gymnastics team scored a school-record 178.525 in a meet
- Men's swimming had the best record in its history (8-1)

Candace L. Royer
Department Head/Director of Athletics

More information about the Department of Athletics, Physical Education and Recreation can be found on the web at http://web.mit.edu/athletics/.

Campus Activities Complex

The Campus Activities Complex (CAC) conducted an extensive review of the department mission as requested by the Dean for Student Life. Through the use of an outside consultant, feedback and input were solicited from principal stakeholders and users of services on both the range and quality of our service offerings. Internal feedback and working sessions among our staff resulted in a revised, clearly defined mission statement. This was reviewed and endorsed by the Campus Activities Complex Advisory Board and approved by the Dean for Student Life.

Based on the new Division of Student Life mission statement, CAC's mission now serves as a basis for departmental decisions regarding our programs and services.

The Campus Activities Complex is accountable for providing an environment where the MIT community comes together, formally and informally, to interact and grow. The mission of the CAC is to:

- Ensure the upkeep, safety, functionality and access to the facilities under our stewardship
- Provide the MIT community basic everyday life services through retail, dining and service operations
- Secure the quality of community interaction through professional logistics, scheduling and production services

In everything we do we advance the values of personal and group responsibility, fairness and respect, as well as appreciation for individual differences.

Advisory Boards

The CAC is assisted in evaluating and fulfilling its mission through the assistance of two advisory boards. These are the Campus Activities Complex Advisory Board and the Campus Dining Board. Each board is comprised of representative undergraduate and graduate students, faculty and staff. Both serve the critical role of providing community input and perspective into the major decisions affecting the programs while providing a channel for communications with those we serve.

Campus Activities Complex Advisory Board

The Campus Activities Complex Advisory Board (CACAB) participated in The Strategic Review and Physical Space Assessment for Stratton Student Center and Walker Memorial Building. The CACAB reviewed and provided feedback to the consultant and working group and is now responsible for facilitating the plans for future renovations of both facilities. To date, the board has participated in two planning efforts to address elements of the report—the Reading Room, and reorganizing the first floor of the student center.

Campus Dining Board

The Campus Dining Board, a panel of students, faculty and staff, was established this year upon the request of Chancellor Clay to conduct a special review of the MIT dining program and meal plan proposals. The result of this review was a set of recommendations, submitted to the dean for student life, which outlined the framework for a new vision in campus dining. The board emphasized the need for a voluntary meal plan and a balanced offering between Institute facilities, personal cooking options, and off-campus dining.

Accomplishments

This was a very busy year for the Campus Activities Complex and its various sub-units. Principal among its many accomplishments were the redefinition of its mission; development of a strategic plan for the Stratton Student Center and Walker Memorial; development of a new dining plan and its resulting changes in contractor relationships; and development of a comprehensive event support fee structure and revenue program for the operation.

Administrative and Retail

A major effort was performed to research, design and implement a comprehensive event support fee system for users of the department's multi-purpose event space. The implementation of this plan, slated for the coming fiscal year, will provide the department an adequate level of funding to properly staff and manage the event support infrastructure and to continually enhance the event and common spaces managed by CAC.

The portfolio of retail tenants maintained the same level of occupancy from the previous year, with plans underway for the conversion of two dining-related tenants into two new restaurants managed under contract by the Office of Campus Dining. In addition, four existing tenants will conclude the remaining term on their lease by the end of the next fiscal year. Where necessary and appropriate, identifying new tenants for the student center will be accomplished by working with the Real Estate Office and by coalescing a broad range of community members that will involve students and staff alike.

The department service offerings included the only 24-hour coffeehouse operation on campus and a revival of a weekly entertainment series located in the Coffeehouse for improvisational and informal performances. Additionally in the fall of 2001, the Stratton Center lobby created an opportunity for community building with a billiard exhibition and the talents of Jack White, a world-renowned billiard trick shot artist. Jack entertained the passers-by with his wit, harm, and incomparable skill of sinking billiard balls into the "side corner pocket"!

Operations, Facilities and Event Management

The event scheduling, planning and support processes of the department continue to be a major focus for CAC. The growth in student activities, DSL initiatives, and MIT-department-related programs has contributed to increased demand on existing event and meeting spaces. Maximizing the use of space and how we support it will continue to be a major priority. We were able to dramatically improve service with the creation and hiring of a technical supervisor position devoted to performing groups using space in Kresge Auditorium and Stratton Student Center. This resulted in a higher level of service in support of the academic Music and Theater Arts Program as well as providing operational and technical support to performance-oriented student activities.

For AY2002, the event management area of CAC provided scheduling and operational support to 12,850 events in which more than 600,000 people participated. Of these events 43 percent were sponsored by student organizations while 55 percent were for MIT departments. The remaining events were individually sponsored, usually for a wedding or memorial service in the MIT Chapel.

In reflecting upon the efforts in our event support area, special note must be made of the significant expansion of the graduate student orientation program that occurred in August. The requirements for space and staff support were significant and coincided with the already significant undergraduate orientation program run through the Office of Academic Services.

Immediately following the start of the school year came the tragedy of September 11. CAC stepped in and helped coordinate a number of Institute-sponsored events, including community gatherings at Killian Court, the steps of the Stratton Student Center, and the MIT Chapel. The department also maintained an information board identifying campus activities and events in response to the ongoing crisis. Finally, in support of the renovations to Lobby 7, the Admissions Office Tour and Orientation Program was relocated to the student center's Transition Lounge for the summers of 2001 and 2002.

The Event Management Team trained individuals in Residential Life and Student Life Programs, Music and Theater Arts, Athletics, Campus Police, Information Center and Conference Services and the Sloan School on the CAC Event Management System (EMS). Now these major clients are able to look up space availability on their own, generate reports, help forecast and be more productive in their individual areas.

The CAC increased its support to student activities in a number of important areas. Dedicated program space was provided to the Outing Club for the installation of a "Boulder Wall" facility in the space adjacent to the Walker Gymnasium. This process required collaboration with other MIT offices in addressing risk management, training, supervision, and facility issues with the club. Office security was enhanced through the installation and use of a new card-based access system, Locknetics, for student activity offices in the Stratton Student Center. The CAC manages the lock systems for student offices in both buildings in collaboration with Facilities and the MIT Card Office. Dance-related student activities benefited by making weekend time available for their use to practice and perform in the Walker Gymnasium.

Student governance groups also experienced increased support from CAC. The Association of Student Activities (ASA) biennial review of space also brought about several reassignments as well as a net increase in assignable office space in Walker Memorial for student group use.

The usefulness of the GSC lounge increased as a result of the collaborative and successful effort of CAC and the Department of Facilities to provide a centralized air conditioning system in that space. Improvements to the common areas of the Student Center were realized with an upgrade to the Stratton Lounge and balcony areas. The effort consisted of a new color scheme for the walls, and new, more-comfortable couches, chairs and tables. On the 5th floor, decorative improvements were made to the Reading Room in the form of furniture and large photographic prints. The photographs, a donation from the MIT Museum, depict student life over the past century. Improvements were also made on the Med-Stop area, inside the Reading Room entrance. Med-Stop continues to be a valuable student resource, offering important information from the MIT Medical Center.

The Source program provided information and ran the box office five days a week. Ticket sales totaled $67,043. The high points were selling extended times for the spring concert and for senior week activities.

Talbot House

Talbot House, located in South Pomfret, Vermont, continued to offer retreat and respite to an increasing number of guests. Through enhanced marketing and attention to the needs of our community, this 27-bed, bunk-style converted farm house and barn provided rest and relaxation to a 25 percent higher number of guests than that of the previous year. Guest reservations were incorporated into the CAC event reservation system with upgrades made to the fire/life safety systems. Future plans for the house include continued facility renewal and furnishing upgrades along with a review of lodging rates.

MIT Mascot

Tim, the MIT beaver, was hard at work this year rallying school spirit in a total of 25 appearances at MIT athletic activities and community events.

Student Art Association

Total class enrollment and membership in the Student Art Association averaged 380 participants each term, with annual enrollment, including Independent Activities Period (IAP), reaching over 1,000 members of the MIT community. The Digital Theatre opened last fall with a full complement of cutting edge digital equipment and techniques taught by professional photographic instructors.

Hobby Shop

We introduced a new Freshman Advisory Seminar, 2A.32 Product Design with Professor Martin Culpepper. In this service-learning class, students studied 3D CAD drawing and woodworking, then designed, built and donated 70 toys to the Codman Square Health Center, a community-based Boston nonprofit.

Once again, the shop collaborated with the Office of Minority Education (OME) and Professor Alex Slocum in the 2.971 Second Summer Design Class. This year, eight students participated in a weeklong intensive shop class to increase their abilities to model their final design.

In addition, we continued all Independent Activities Period (IAP) classes and programs from the previous year. In the spring term, SP.745 Green Woodworking was fully attended and a new non-credit class, Building a Subwoofer, was added at the request of students from previous loudspeaker classes. In the summer of 2002, three classes will be offered. Students can learn to build a picture frame, floor lamp or post and rung stool.

Office of Campus Dining

This year represents perhaps the most important period of change for the office in the past 20 years. Much of the groundwork has been laid for a new and robust dining program, which will attract faculty, students and staff and begin to realize the community vision and role for dining articulated in the Task Force Report on Student Life and Learning.

The Campus Dining Board (CDB) made specific contributions and recommendations associated with meal plans and the forward-moving direction of campus dining. Chief among these recommendations was to maintain a voluntary meal plan and to achieve a balance of choices for students that includes commitment to Institute dining facilities, personal cooking, and off-campus dining. Equally important was the commitment to creating a competitive environment among food service providers on campus.

Instrumental in creating this new competitive environment was the split of the sole-source contract arrangement with ARAMARK and the incorporation of independent merchants on the MIT Card. A plan was developed and endorsed by the Campus Dining Board and Dean Benedict to divide the existing contract along three business lines: Faculty Club/MIT catering, for which ARAMARK was to be retained based on quality of service and high customer satisfaction; community dining, representing the Lobdell Food Court, Walker Memorial, and most small cafes throughout campus; and residential dining at Baker House, Next House, the new Simmons Hall, and the MacGregor Convenience Store.

A request for proposal (RFP) process was successfully completed in May through Procurement and an eleven-member Vendor Search Committee (VSC) was formed, including Campus Dining Board members, student leaders, faculty, staff and administrators. The VSC prepared an evaluation of vendor proposal strengths and weaknesses which was then endorsed by the CDB and provided to Dean Benedict for his consideration. Dean Benedict's selection of two new food service contractors, Sodexho in community dining and Bon Appetit in residential dining, was consistent with the VSC's evaluation and was thought to provide the best solution for reaching the Institute's goals for dining.

Administrative Changes

Given the mission of department in supporting the broader MIT community, most of our activity depends on extensive collaboration with other DSL and Institute departments, student governance, and student activity groups. Administrative changes were no exception, as collaboration with others provided the vehicle for accomplishments across CAC. Central among these was the review and re-definition of the department's mission statement.

The department produced two major reports this year, The Strategic Review and Physical Space Assessment for Stratton Student Center and Walker Memorial Building, and Building a Dining Program at MIT—The Interim Report of the Campus Dining Board. The Strategic Review looked at the mission, vision, current and future uses of facilities, and their relationship to other major hubs of activity on campus. The report serves as a blueprint by which future space and program changes can be initiated and evaluated. The interim report was developed at the request of Chancellor Clay and was submitted to the dean for student life on April 15, 2002. The report reflected a reassessment of dining's business plan, evaluation of community needs and desires, and provides a model by which a business plan can be developed and evaluated. This report and its findings are currently under implementation.

The MIT Card Office was transferred to Enterprise Services, under the Executive Vice President, this year. This organizational change resulted in the removal of the meal plan/debit system from the Office of Campus Dining.

The offices of ARAMARK's administrative staff were moved to the basement of the Stratton Student Center, allowing their former space on the fifth floor to be renovated and reoccupied by DSL staff.

Finances/Funding

In reaction to the funding gap between event support needs and community expectations, a report was developed that analyzed the cost of event support functions and what would be necessary to provide a quality program. This analysis resulted in a recommendation to create a new, comprehensive event fee structure to be applied to users of CAC facilities. This was submitted as part of the CAC FY2003 budget request and was adopted for implementation beginning July 1, 2002.

Within the office, new financial frameworks were established based upon the determination to continue voluntary dining programs for the community. New and expanded vendor relationships as well as decisions to retire early, some existing institute debt, all point to a continuously improving financial picture over the near-term.

All campus food providers, including La Verde's store, have made commitments to accept the MIT Card providing a maximum of choice and convenience for students.

Staffing Changes

New hires include Tony Machado, assistant manager of night operations; Dave Kemp, supervisor of technical services; Katie Clapp, administrative assistant to the department head; and Christie Wright, senior office assistant/Talbot House coordinator; and in the Hobby Shop, Roy Talanian, technical instructor (part-time).

The re-organization of campus card functions resulted in the transfer of the Meal Plan Office (debit system) and its staff of June Hagar and Cecilia Griffin from the office to the new centralized MIT Card Office.

Lianne Scott and Edward McCluney distinguished themselves with performance based awards this year. Lianne received a DSL/DUE Infinite Mile Award for program innovation. Ed was named this year's recipient of the prestigious Gyorgy Kepes Fellowship Prize.

Phillip J. Walsh
Director

Community Development and Substance Abuse Programs

The Office for Community Development and Substance Abuse Programs (CDSA) functions to engage all members of the MIT community in a comprehensive and integrated effort to enhance academic, social, and personal development. The CDSA office relies upon research and the application of data to strategic planning and service delivery. Overall, the CDSA office advocates for the strengthening of a campus culture promoting informed, responsible decision-making and the reduction of harm that is often associated with substance use and abuse, including poor academic performance, violence, high-risk sexual behavior, sexual assault, and addiction.

Accomplishments

In early 2002, the appointment of associate dean Daniel Trujillo and Kimberly Stepan, community development associate, marked the beginning of the CDSA office within the Division of Student Life.

The CDSA strived to develop collaborative partnerships with multiple stakeholders within MIT including faculty, students, MIT Medical, Mental Health, Counseling and Support Services, Residential Life and Student Life Programs, as well as the broader community, including the City of Cambridge, City of Boston, and the State of Massachusetts.

Student assistant Lawrence Colagiovanni was hired and the division developed the CDSA Student Advisory Coalition functioning to advise and participate in department initiatives and strategic planning.

Office infrastructure and staff roles/responsibilities were developed and implemented.

Administrative Initiatives

The CDSA office has initiated and is currently conducting a review of all alcohol and other drug policies, procedures and their implementation. Such a review is intended to inform future revision or development of policies or procedures, and to maintain partial compliance with the Drug-Free Schools and Campuses Regulations (34 CFR Part 86).

As an additional component for compliance with the federal Drug-Free Schools and Campuses Act, the CDSA office composed the "Statement on Drug Free Schools and Campuses" a document that requires specific content and must be circulated to all students and staff. Beginning in the fall of 2002, the "Statement on Drug Free Schools and Campuses" will be printed in the *MIT Bulletin* and the class schedule for fall 2002 and spring 2003.

A campus climate assessment was designed and distributed to assess those environmental factors that may function to promote substance abuse/misuse, as well as factors that may protect individuals from the abuse and harms associated with substance abuse.

The CDSA office, in collaboration with MIT Medical, has planned a campus survey of behaviors, attitudes and perceptions associated with MIT student health to be conducted during AY2003.

The environmental and individual assessment approach is intended to enhance understanding of the societal and individual contributors to substance use and the magnitude of alcohol-related problems.

The provision of community support through educational outreach programming was a major initiative for the spring 2002 term. CDSA created and implemented five Community Forum town hall meetings for administration and students to discuss issues and policies associated with alcohol and other drugs; four Community Interventions programs tailored to residential floors, greek chapters or dormitories to discuss specific issues within the community and devise a response to address or prevent similar issues in the future; multi-media informational resources through informational brochures, posters, and advertisements; support initiatives for parents including distribution of the Alcohol 101 interactive CD-ROM and information for parents describing how to talk to your student about alcohol and other drugs; and co-sponsorship of events and programs with student organizations and other departments.

The CDSA office has begun to develop and implement the training component of its strategic plan. This initiative is designed to increase the awareness of alcohol and other drug issues, as well as enhance the skills and capacities for community members to assist and support one another. The CDSA office has provided seminars and in-service training to MIT professional staff from multiple departments, including Counseling and Support Services, housemasters and graduate resident tutors, the Mental Health department of MIT Medical, the Medical Consumer's Advisory Council of MIT Medical, and the annual MIT Medical conference seminar for health care professionals sponsored by the Harvard Medical School and Massachusetts Nurses Association.

The CDSA office intends to increase training of students and student organizations regarding the personal, social, academic and legal issues associated with substance use. Examples of such training opportunities from the previous spring term include efforts with the Interfraternity Council, Dormitory Council, the Medlinks peer program, and eleven residential living groups (including dormitories, living groups, fraternities and sororities).

Over the previous term, the CDSA office also provided community consultations to multiple organizations and

departments throughout the Institute. These consultations varied in focus from policy and procedure issues, legal regulations and liability, to the effective detection, intervention and referral of individuals with alcohol or other drug problems. The CDSA office has been involved in over 30 consultations with different segments of the MIT community, including the Graduate Student Council, Dormitory Council, the editorial board of *The Tech*, residential life associates, Sloan School, Student Athlete Advisory Committee, faculty, housemasters, graduate resident tutors, fraternities, sororities and living groups.

In partnership with MIT Medical, the CDSA office has worked to coordinate and implement the BASICS program (Brief Alcohol Screening and Intervention for College Students) for the second year at MIT. Over the previous year the program provided for two-thirds of Mental Health service staff at MIT Medical to be trained as BASICS counselors. The online screening of first-year students resulted in 872 students completing the questionnaire. Based on certain criteria in the students' responses, students were screened for one-on-one sessions with trained counselors. Of the 75 students who met the screening criteria last year, 16 agreed to participate.

The social marketing initiative represents the development of a comprehensive media campaign to address multiple health issues. The CDSA office, in collaboration with clinical and professional staff from MIT Medical and MIT students, has formed the Social Marketing Committee to address a range of student development issues. The CDSA office coordinated a media design competition for MIT students to develop a campus-based alcohol social norm campaign. This campaign is designed to correct the widespread misperception that certain behaviors associated with alcohol use are normal and acceptable. The alcohol portion of the campaign is to be implemented in the fall of 2002. The comprehensive media campaign will be developed during the fall 2002 term and implemented during the spring 2003 term.

A significant means to prevent alcohol use and abuse involves the frequent availability of social opportunities on campus that do not include alcohol. Over the spring 2002 term, the CDSA office was one of several MIT departments to provide support for these types of social activities.

The Campus Alcohol Advisory Board (CAAB), an Institute-community coalition, successfully developed and implemented 18 "Frank Talks about Alcohol" programs in the student living communities. CAAB represents a component of a proactive policy for MIT to enhance relations with the Cambridge License Commission and other city agencies. MIT is represented by the CDSA office on the Cambridge Licensee Advisory Board (CLAB). This coalition is designed to bring tavern and package store licensees who distribute alcohol together to address underage alcohol consumption.

The CDSA office has also become an active member of the Massachusetts Statewide Coalition to Address Problem Drinking, coordinated through the Massachusetts Department of Public Health and attorney general's office. Working with the MIT Police, MIT Medical, and the trained student emergency medical technicians, the CDSA office has functioned to coordinate a medical support system and create procedures designed to enhance service delivery to the student communities. This support includes approaching medical intervention cases involving alcohol as a health issue that requires a medical/mental health response.

Daniel A. Trujillo
Director

More information about Community Development and Substance Abuse Programs can be found on the web at http://mit.edu/cdsa/.

Counseling and Support Services

Counseling and Support Services (CSS) provides personal and academic-related counseling and advising services for students. In its counseling and advising role, the department provides a number of services to the community. Working with MIT Medical, particularly the Mental Health section, CSS supports students in need or crisis. CSS also provides supervision for Nightline, a peer counseling hotline. In addition, CSS staff participates as non-voting members of the Committee on Academic Performance, process applications for leave of absence and readmission as well as requests for voluntary and medical withdrawals. The department also serves as a resource for parents, faculty, campus police and university administrators. Finally, CSS provides specialized programming for the diverse student constituencies.

Accomplishments

CSS initiated a review of student medical leave and insurance policies. The study is focused on the impact these policies have on active as well as non-registered degree candidates.

The department undertook a review of the dependencies between student financial aid and medical and voluntary withdrawal processes.

CSS worked with MIT Medical to continue to identify opportunities for collaborating to improve delivery of services to the MIT community.

Furnishings in the Cheney Room were upgraded to provide a more comfortable space for user groups.

Programmatic Initiatives

Women Students

CSS participated in the planning and development of the Rape Awareness Program which was incorporated into the orientation for first-year students. Several members of the CSS staff facilitated discussion in small group sessions which followed the presentation of the featured speaker, Katie Koestner.

CSS sponsored ongoing group discussions throughout the year in various settings including freshwomen luncheons, African-American women's dinners, Asian and Asian-American women's dinners, and for the Graduate Women's Group.

Department staff all participated in Emotions 101. This IAP seminar for students and staff focused on the value of emotions and explored techniques for dealing constructively with emotions. In addition, CSS offered a seminar entitled Honoring Ourselves as Women to explore attitudes that women hold about being women and joined Medlinks with delivery of Listening and Responding Skills for Peer Advocates.

Minority Students

Staff remained active on the Campus Committee on Race Relations and the Martin Luther King, Jr. Committee. CSS staff were active in the Black Women's Alliance and Mes Latino. In addition, CSS provided support for the MLK Leadership Awards selection and participated in an open house for the BSU. CSS staff also worked with Office of Minority Education Project Interphase students and with high school students in the MITES program. The MLK Committee selected Tavis Smiley, network news commentator, author, social activist and NPR host, as the keynote speaker for this year's breakfast.

Asian and Asian-American Students

The School of Humanities, Arts, and Social Sciences and CSS sponsored a lecture by Chang Rae Lee, author of *Native Speaker* and winner of the National Book Award and PEN/Hemingway Prize. In addition, Mr. Lee participated with students in several literature and writing classes.

The Asian Women's Luncheons enjoyed strong attendance throughout the year. The group hosted speakers on business, arts and medicine.

Gay, Lesbian, Bisexual and Transgendered Students

CSS collaborated with MIT Medical to provide leadership for a support group for gay undergraduate and graduate students. The department contributed to the planning and development of the LGBT resource center.

Orientation and Training

CSS staff provided training on "How to Make A Referral" for housemasters, graduate resident tutors and resident advisors in the Fraternities, Sororities and Independent Living Groups. CSS staff met with first-year student advisors to discuss danger signals and Institute resources. Department staff also participated in Campus Preview Weekend and sat on panels during Parents' Orientation and Family Weekend. CSS staff also worked with instructors in the Program in Writing and Humanistic Studies to examine ways in which they can offer support to students who may be in or headed toward crisis. Particular emphasis was placed on paying attention to details that are sometimes revealed in autobiographical and expository writing.

After September 11, 2001

Even students not directly affected by the September 11 terrorist attacks on Washington, DC and New York reported feeling numb, displaced, or anxious. As days passed, others complained of being unable to sleep, concentrate, or remain motivated. Some questioned themselves, their goals and the direction of their lives. Others became angry and would fly into rages against

unsuspecting friends or innocent loved ones. And, there were those who lost relatives and friends in the attacks. Many of these individuals did not come forward in the first weeks or even months. Some could not and did not talk about their grief until the winter final exam period. Undoubtedly there are some who are still quietly trying to cope with their grief.

In the aftermath of September 11, CSS staff met with the imam in the MIT Chaplaincy and made a commitment to developing better understanding and cultural sensitivity throughout our exceptionally diverse campus community. Initial efforts toward this goal included an informational article in *Tech Talk* and a video about Muslim students.

Administrative Initiatives

Processes related to voluntary withdrawal and readmission were refined. Instructions and methods of notification were clarified.

The department worked with the associate registrar to clarify procedures for granting medical withdrawals.

The associate dean for counseling supervision and training worked with the associate chief of mental health to strengthen communication and identify opportunities for collaboration between the two offices.

The section head was named as co-chair of the Mental Health Task Force Implementation Group.

In addition, the department collaborated with Academic Services to continue to improve communications related to readmitted first year students.

The department developed a brochure designed to provide an overview of the services available through Counseling and Support Services.

Against the backdrop of September 11, the fact that MIT did not have a suicide during the school year seems to be a small matter. In truth, the community has been on edge the entire year. Random Hall is especially fragile. Random experienced the two most recent suicides on campus, and that community has come under intense scrutiny by the press as well as the public. We lost a graduate student in the spring—cause of death unknown. We have not had a suicide on campus since May of 2001. The absence of such tragedy is worth noting.

Staffing Changes

Denise Meehan, formerly of MIT Mental Health, joined DSS as an administrative assistant in November 2001.

Arnold R. Henderson, Jr.
Director

Housing

Housing strives to provide a safe, secure, and well-maintained environment for our students, faculty, and guests by maintaining facilities at the highest quality in support of the Institute's broader educational mission.

Through our programs of assignments, special needs support, capital construction, renovation, repair and maintenance, along with programs in fire and life safety, recycling, off campus housing and evening security, we strive to provide our residents with a special place to call home.

Organizational Change

Throughout the past two years, Residential Life and Student Life Programs (RLSLP), which was composed of the various sections of Student Life Programs and Housing, have worked closely together to provide high-level services to our students, faculty and guests. To more clearly reflect responsibilities, scope and range of services for our students, customers and the MIT community at large, RLSLP has moved forward to become two units—Student Life Programs and Housing.

Housing includes teams responsible for construction, renovation, and repair and maintenance; undergraduate, summer, and guest housing; graduate and family housing; operations; evening operations and nightwatch; off-campus housing; and administration, I/T and finance.

With this transition, Housing has carefully reviewed its constituents' needs in relation to the services provided and determined that more effective communication of responsibility would benefit the community.

The following titles were determined to communicate the breadth and scope of responsibility: Karen Nilsson, department head, director of housing; Carl Seagren, assistant director of operations; Kenneth Winsor, assistant director, Evening Operations; Loretta Hewitt, assistant director, Graduate Housing; Anthony Davis, assistant director, I/T Administration; Denise Vallay, assistant director, Undergraduate, Summer, and Guest Housing; Linda Patton, assistant director, Off-Campus Housing and Special Housing Projects; Christopher Nolan, assistant director, Renovations and Construction; and Judith Brennan, administrative coordinator.

Accomplishments

I/T Administration

I/T Administration provides services to both Housing and Student Life Programs.

Special Projects

I/T Administration worked with Facilities to bring the electronic repair work order system, Maximo, on line in all of our residence halls providing for computer ease in reporting repair needs and providing an electronic work repair tracking system.

To enhance evening operations we worked together to purchase the new Morse Guard Watchman System, that has been implemented into our nightwatch patrol nightly procedures.

To provide more networking opportunities for our residents, we worked with MIT I/S in the establishment of two additional residential Athena clusters for Tang Hall and New House.

Working with MIT I/S we have begun a project scope review for feasibility and upgrading of the residential network infrastructure to 100-MB processing. This process may result in lost bed space and rental income, closet space and construction expense to implement this program.

Computer and Network Enhancements

As part of our overall computer upgrade program, we deployed approximately a third of new/replacement desktop machines for our staff as well as ordered and set up new desktop computers for each new employee. To provide for better computer backup, we moved all our users to the Institute's TSM back up service. We deployed desktop computers or laptop computers to housemasters as required.

Construction, Renovation, Repair and Maintenance

Major Capital Projects

We continue to work with Facilities and the Treasurer's Office on construction initiatives for Simmons Hall and the Sidney-Pacific Graduate Residence. Much of the focus at this time is related to building opening and student move in dates.

Funds have been secured to address our ongoing program of complying with ADA standards. The W71 front entrance handicap accessibility project will be started and completed this summer. This past summer W51 front desk/entrance was completed as part of our ADA program.

Housing continues to work on the second phase of the W85 playground renovation. Much of the effort during this phase has been collaboration between Facilities, architects and engineers. The design and scope of work for playground landscape are in review, scheduled to be completed the summer of 2002. This project will greatly benefit the families and children of W85 as well as address many issues surrounding the water run off/drainage of this landscape.

Funds have been made available for the renovation of the housemasters' kitchen in W1. The completion of this

project is scheduled for the summer of 2002. This is part of the ongoing program of upgrading housemaster kitchens, giving them more opportunities for holding events with their residents involving food preparation. Both W13 and W51 housemaster kitchens were completed this past year.

Fire alarm systems upgrades at W13, W1 and W51 have been completed. State-of-the-art Life Safety fire systems have been installed and are functioning at these locations.

Completed Capital Maintenance Projects FY2002

Window replacement/window security screens: NW61, W1, W84

Waterproofing/pointing: W51

Bathroom renovations: 62-64, E55, NW61, W1, W4, W5, W13, W51, W61, W70, W71, W84, W85

Kitchen renovations: E55, W1, W4, W5, W13, W51, W61, W70, W71, W84, W85

Plumbing/mechanical renovations: 62-64, E55, NW61, W1, W4, W5, W13, W51, W61, W70, W71, W84, W85

Electrical upgrades: 62-64, E55, NW61, W1, W4, W51, W70, W71, W85

Paint program: All Dorms

Fire alarm upgrades to state-of-the-art systems: W1, W13, W51

Front desk and/or entrance renovations: W51, W13

Housemaster kitchen renovations: W13, W51, 62-64,W1

Playground landscaping renovation, second phase was completed, W85

Lighting upgrades: E55, W85, W84, W5, 62-64,W13, NW61, W4, W51, W61, W70, W71

Capital Planning 2003

Window replacement: W1 ongoing, W84 ongoing

Bathroom renovations: W85, E55, W1, W5, W84, W13, W61, W4, W70, W71, NW61, W51, 62-64

Kitchen renovation: W85, E55, W1, W84, W13, W61, W4, W71, W51

Plumbing/mechanical renovations: W85, E55, W1, NW10, W5, W84, W7, W13, W61, W4, W70, W71, NW61, E2

Electrical renovations: W85, E55, W1, W84, W13, W61, W4, W70, NW61, E2

Paint program: all dorms

Housemaster kitchen renovation: W1

Final phase of W85 playground renovation

W71 front entrance (ADA), front desk W1

W61 courtyard renovation

Operations

In response to concerns surrounding the events of September 11, all house managers received training by Mail Services on hazardous materials via mail delivery. Plans are underway for additional fall training including training for student desk captains.

Central operations staff and house managers have increased security at desks and are active members of the house teams made up of house managers, housemasters and graduate resident tutors (GRTs).

House staff continued to be major player on the EPTF Group working with student groups to increase housing buildings recycling.

Fire safety remains a priority for Housing. Drills took place in the afternoon to include our daycare centers and all children living in Eastgate and Westgate. The Cambridge Fire Department joined our drills and provided opportunities for the children to talk to the firefighters as well as to see and sit in a fire truck.

Operational planning is underway for the opening of our two newest residential buildings, Simmons Hall and Sidney-Pacific scheduled for fall of 2002.

Evening Operations and Nightwatch

Evening Operations continues to enhance our security and safety standards for our residential facilities. Much of this is credited to our in-depth training sessions with the Environmental Health and Safety Office (EHS) and MIT Police.

Reorganization of our evening operations staff has provided for more efficiency and effectiveness. Specifically we have addressed various operational challenges that occur on the evening shifts. We continue to work with each house team in order to support their specific needs.

We have established security programs for our newest dorm, NW-30, also known as the "Warehouse."

We have purchased an upgraded electronic watch patrol system, Morse Guard Watchman System, that streamlines our ability to monitor our dorm patrol rounds.

We are planning security programs for Simmons Hall and the Sidney-Pacific Graduate Residence for August 2002 opening.

Undergraduate, Summer, and Guest Housing

For the third year in a row, a second lottery was necessary to assign all freshman students to housing. At the end of the first lottery, there were still 99 students who were not assigned. As a result, 189 students were crowded into undergraduate housing last year.

Housing staff served on the Residence System Implementation Team (RSIT), chaired the Freshman Residence Orientation and Selection of Housing Committee. This committee had three sub-committees: Publications, Residence Orientation (formerly known as "rush"), and Assignments. Committee members included students, Dormitory Council leadership representatives, Student Life Programs and Housing staff, and a housemaster.

Housing staff served on the Institute's Enrollment Management Committee and worked with this committee on issues such as undergraduate over-crowding and transfer student enrollment and housing.

To increase customer service, all housing change requests, housing confirmations, cancellations, summer and guest housing requests and early return requests are available via our web sites to reflect the new housing procedures. *The Guide to 1st Year Residences* was completely overhauled and redesigned to help showcase the unique aspects of MIT's housing options and procedures.

To help alleviate the crowding problems we faced in undergraduate housing during the fall term of 2001, the Senior Segue program was implemented. This gave 80 undergraduate students the opportunity to move into graduate housing for their senior year and also guaranteed them housing for their first year of graduate school at MIT.

To help fulfill the goals of the Bacow Report and increase liquidity and movement between the undergraduate houses, we ran a spring housing upper-class student lottery. As a result, 350 students were reassigned to a new residence hall. Some of those students had been on the waiting list for two years.

Our summer conference and guest programs continue to increase, and this year NW30 was added to provide additional bedspace for conference housing.

Graduate and Family Housing

This year, 40 percent of MIT's graduate students received on-campus housing.

Demand for family housing (graduate and undergraduate) continues to increase. The need for review of this housing population continues.

A new user-friendly web-based housing application form was brought online, enabling more convenient service and a more efficient lottery. Computing and use of MITSIS continues to improve service. We worked with IT to implement new billing codes for all graduate buildings. The implementation of this new billing system allows the graduate office/assignment coordinators to bill and print license agreements for the many different student categories added to the graduate system this year, i.e. the undergraduate senior segue and sorority programs.

In collaboration with the Graduate Student Council (GSC) and deans for the graduate school and student life, we developed new housing policies,.

In the fall of 2001, the new graduate residence hall, NW30, opened, adding an additional 120 efficiency apartments for graduate students. This building is also used to accommodate conferences and guest housing during the summer months (June through August). Expected to open in the fall of 2002, the Sidney-Pacific Graduate Residence will be the largest building to house students on campus. The addition of this building will enable us to provide guaranteed housing to all new first-year single graduate students. Sidney-Pacific will also contain commercial businesses, making it the most diverse housing facility on campus.

The Graduate Assignments Office was a key participant in the implementation of the Senior Segue program. By reassigning undergraduates to graduate housing we were able to help alleviate some of the crowding in the undergraduate system.

Off-Campus Housing Service and Special Projects

We began to offer information on available rentals on a secure web site in March 2001. Students, staff, and faculty continually use this web site to check for available rentals. Usage of the site has far exceeded our expectations. We are currently working on a second-phase version of this electronic program for the fall of 2002 that will allow property owners to post their rentals online and greatly expand the search mechanism for our affiliate users of the site. We anticipated a decrease in office visits, but the summer months still have a high volume of in-office consultations.

The market off campus is improving. After a six-year period of increasing rents and low availability, the rental market appears to be stabilizing. The large volume of available apartments can only benefit our community and may force the rents to decrease to a more affordable level for our affiliates.

Requests for guidance on landlord/tenant law remains high. There are many new property owners in the area that are not aware of their responsibilities as landlords. We have located a "new landlord" information document that we

share with the property owners in an attempt to educate them about their responsibilities. We continue to share copies of "Legal Tactics" with our affiliates to assist them in resolving difficulties they may be experiencing with property owners off campus.

Our staff is available to offer more personal guidance as needed.

MIT-owned apartments off campus for graduate students continue to be popular. Historically the rents were lower than market, but this may change in the future. The apartments offer a convenient location and excellent management and greatly expand our ability to assist our graduate students and their families.

A personnel policy manual is being developed for the Housing staff and will be available in the near future.

The annual City of Cambridge census data was collected electronically this year, greatly reducing the volume of paperwork. Also the number of responses from our students was greatly increased by the use of email in place of a paper survey.

Staffing Changes

Denise Vallay was promoted from administrative assistant to manager of undergraduate housing, summer and guest housing.

Michael Cammarata was promoted from administrative assistant to assistant manager of evening operations.

Charlene McLaughlin was promoted from dorm patrol to administrative assistant for evening operations.

Joe McCarthy returned to service staff as a dormitory patrolman.

Joe Graham was promoted from dorm patrol to house manager of East Campus.

Curtis Soo Hoo was hired as house manager of New House.

Carla Bengtson was hired as the training house manager, stationed at Eastgate.

Colleen Honohan was hired as house manager of McCormick Hall.

Michael Collins was promoted from the MIT Card Office to house manager of Westgate/Tang.

Dennis Collins was transferred as house manager from Westgate/Tang to Sidney-Pacific.

Rui Borges transferred from Mail Services to house manager of Simmons Hall.

Diana Quinlan was hired as an administrative assistant in graduating housing.

Jason Wentworth was hired as an administrative assistant in graduate housing.

Karen A. Nilsson
Director

Student Life Programs

Student Life Programs (SLP) focuses on supporting the learning experience for all students at MIT in the areas of intellectual, personal and social development that occur beyond the classroom.

Through our collaborative work with students, SLP seeks to create a variety of opportunities which promote faculty and student interaction, encourage student responsibility and concern for others, and foster the development of essential life skills allowing students to establish meaningful relationships within the MIT community and beyond. We strive to enhance the student experience at MIT by working closely with colleagues throughout the Institute as well as staying abreast of current professional knowledge and best practices within higher education and student life.

The 2001–2002 year has been a very successful year with significant accomplishments, as detailed in the following report, achieved by the various offices comprising SLP. Additionally, the SLP offices came together to identify three key areas for focused attention this year. Those areas were:

- building an infrastructure to serve as a strong foundation for ongoing program development
- addressing issues of risk that affect the health, well-being and safety of students
- striving to build a stronger sense of community at MIT with a special focus on students

Each of these areas has involved significant improvement this year with continued opportunities for enhancements in the coming years.

The work of the Residence System Implementation Team (RSIT) throughout 2001–2002 required extensive commitment from approximately twenty committee members in the planning efforts for August 2002. RSIT planned for and implemented the specific changes involved with the decision to house all first-year undergraduates on-campus starting fall 2002. These efforts involved ongoing collaboration with various areas including: the dean for undergraduate education (DUE), the dean for student life (DSL), administrative departments on campus, and most importantly, the undergraduate students.

As AY2002 draws to a close, a structural and organizational change will be implemented. Throughout the past two years Residential Life and Student Life Programs (RLSLP), composed of the various sections of Student Life Programs and Housing, have worked closely together to provide high-level services to our students, faculty and guests. However, to more clearly reflect responsibilities, the scope and range of services for our students, customers and the MIT community at large, RLSLP has become two units: Student Life Programs and Housing. It is anticipated that the close working relationships in these areas will continue as will the quality of service.

Student Life Programs includes Residential Life Programs; Public Service Center (PSC); fraternity, sorority and independent living groups (FSILG); Student Activities Office; Lesbian, Bisexual, Gay and Transgendered at MIT (lbgt@MIT); administration, I/T and finance.

Accomplishments

Faculty in Residence

Last year, the undergraduate housemasters worked closely with their own residence halls and with DSL to accommodate the unprecedented crowds of AY2002. They also worked with their residence hall teams to help them prepare for the residential system changes going into effect in September 2002. In addition, the Housemaster Council became involved in a series of campus-wide issues, including crowding in the undergraduate houses. With the graduate housemasters taking the lead, the Housemaster Council helped DSL formulate plans for temporarily utilizing the increase in graduate housing space due to the opening of Sidney and Pacific to lower the current level of undergraduate crowding. With this work came an enhanced understanding of the need to look at undergraduate and graduate residential life as one shared system.

The Housemaster Council took an active role in working out a process to house all freshmen on campus in the fall of 2002. Ellen Essigmann represented the Housemaster Council on the Residence System Implementation Team (RSIT). In response to DSL's decision to not require residence halls to permit first-year students to "squat" their initial summer assignment, the Housemaster Council worked with DSL to develop a policy of "home rule" whereby each residence hall would establish its own rules for first-year room assignments. As a result of this cooperative effort, five of the twelve undergraduate residence halls plan to continue to allow some level of freshman "room squatting". In addition, the Housemasters Council worked with RSIT to adapt the proposed orientation schedule to ensure that all first-year students will be able to move into their final rooms by Thursday of orientation.

Housemasters are also playing a role in facilitating the transition to a new campus dining model. William Watson has served on the Dining Review Board, and Bora Mikic has been playing an active role in the upgrading of dining at Next House. The Simmons Implementation Group successfully drew up a new approach to dining that has been approved by the newly formed Simmons undergraduate community and DSL.

Overall, the housemasters report that the new residential life associate (RLA) program has provided a valuable new resource to the housemasters and residents. They have their own programs in the residence halls and, in addition, provide a backstop to complement the housemaster-GRT resource in the living groups. In addition, two documents have been developed to clarify the *Roles and Responsibilities of the Housemasters* and the *Roles and Responsibilities for the Graduate Resident* Tutors (GRTs). The housemaster document was compiled and approved in June 2001 and the GRT draft document is in the process of being completed by a committee with housemaster and GRT representation.

Fraternities, Sororities, and Independent Living Groups

The FSILG area continued to offer leadership opportunities and workshops for chapters and officers. The area relating to operations and facilities was streamlined due to addition of a new professional position dedicated to the specific area. The Institute committed monies to support the FSILGs during the 2002 transition with additional support dedicated to fund programs and initiatives that will help prepare chapters with the transition.

Over the past several years, the Panhellenic Council has assumed greater leadership for MIT's sororities and has been a larger participant in campus-wide issues, culminating in this year's separation from the InterFraternity Council (IFC). Already we have seen an increased voice by the Panhellenic Council for women's issues at MIT and an increased capacity by both groups to better focus on their core needs and issues.

Programs completed during the year included the President's Leadership Retreat, a New Member Retreat, and Council Executive Board Retreats. Other programs included various roundtables and workshops, most specifically designed to assist chapters with the 2002 transition. Several members of the IFC and Panhellenic Council attended the Northeast Greek Leadership Association (NGLA) in Philadelphia where the IFC was awarded the Chapter Management Award. An MIT IFC representative attended the Undergraduate Interfraternity Institute (UIFI) in Indiana and several staff participated in the program as facilitators. Staff have also facilitated or participated in several leadership conferences, including SALAD, national conferences for Sigma Phi Epsilon and Alpha Epsilon Phi, and AFA/NIC.

Twenty-one of the 23 Boston FSILGs had a voluntary proactive inspection by the Boston Fire Department. All 10 Cambridge houses passed their annual egress inspection in May 2002. Over the year two house manager roundtables were held. The first one was centered around fire safety and the second was targeted at summer and winter closings. The house manager's manual was overhauled and disseminated. Processes were established for distributing MIT facilities and safety information to house managers and resident advisors (RAs) and for identifying and compiling approved vendors as a shared resource for all FSILGs.

MIT committed $750,000 for FY2003 to assist in the transition from rush during orientation to a traditional recruitment program that will disallow freshmen from living in the FSILGs. The financial support will decrease over a three-year period and will reimburse chapters for 80 percent of the fixed costs of those members that would have typically moved into the chapter house prior to the 2002 transition. A portion of the $750,000 will also be used to support programs and initiatives that will enable chapters to better prepare themselves for the transition.

Seven RAs offered programming opportunities for their members and were given $250 to support their effort. Chapters were reimbursed a total of $215,000 for the fixed costs associated with housing a resident advisor. Twenty-eight of the 35 resident advisors are planning on returning next year.

There were seven judicial cases heard by the IFC or the administration ranging from alcohol violations to rush infractions, with sanctions ranging from educational programming to social probation.

The FSILG staff continues to work with MIT's 25 National Interfraternity Conference fraternities, five National Panhellenic Council sororities, two local fraternities, and five living groups in a continued effort to prepare the chapters and houses for the many changes taking place within the FSILG community, particularly in the area of recruitment and retention of new members.

Lesbian, Bisexual, Gay and Transgendered at MIT

Last year, Lesbian, Bisexual, Gay and Transgendered at MIT (lbgt@MIT) redefined its four primary goals. Ongoing efforts, such as the monthly email newsletter, the "You Are Welcome Here" Campaign, the *Lavender Guide*, and Coming Out Week and ToBGLAD activities, continue to be vital to creating a more welcoming and inclusive campus. However, many new initiatives were undertaken in each of the primary goal areas.

In its effort "to ensure appropriate resources are readily available," lbgt@MIT collaborated with Counseling and Support Services and MIT Medical to develop support groups; a gay men's support group began this spring. A new organization for gay, straight, bisexual and transgendered women, QWiLLTS (Queer Women Looking for a Life in Tech School), was founded as a means to better address the needs of women students. The Rainbow Center (Room 50-306) opened its doors this year as both a lending library of resources and a shared home to all of MIT's LBGT student organizations. The support of the Undergraduate

Association and Counseling and Support Service were instrumental in the center's development.

"To foster campus-wide dialogue," lbgt@MIT collaborated with SLP staff to bring *Journey to a Hate Free Millenium*, a multimedia presentation to address hate crimes and bias on campus. A stronger commitment has been made to provide support to MIT's transgendered community. This year, we sponsored a panel discussion for the campus community and formed a committee to work for the addition of gender expression to MIT's nondiscrimination clause.

In celebration of the LBGT community, Nils Fonstad was awarded the John S. W. Kellett '47 Award at the Institute Awards Convocation for his efforts to create a more welcoming community at Sloan and across MIT. In addition, graduating students were recognized in our second annual Lavender Graduation.

The encouragement of participation and collaboration is a theme in all of our work and accomplishments. In particular, this year, the LBGT Issues Group realigned itself to better provide advisory support, advocacy, and community participation opportunities. Carol Orme-Johnson stepped down as chair of the LBGT Issues Group after six years of dedicated service to enable the formation of a broadly representative steering committee to provide leadership and direction to the group. The first steering committee will consist of graduate students Joyce Yang and Katarina Midlefort, Assistant Professor Jim Cain, and staff members Chris Pomiecko and Michele Oshima. It is important to note that volunteer efforts continued to provide the majority of efforts to support LBGT individuals, continuing to cause concern regarding sustained and ongoing services.

John Kellett contributed an additional $20,000 to support LBGT programs ($8,000 to BGALA and $12,000 to the LBGT Issues Group). A proposal was submitted and accepted by Chancellor Clay to provide $10,000 to support a 2002–2003 speaker series. This year, the LBGT Issues Group provided financial support to the following events: a same-sex marriage talk by E. J. Graff, a film festival celebrating Native American film makers, and a panel discussion on Third Wave Feminism and Art Activism.

Public Service Center

The Public Service Center (PSC) continued to expand its outreach to the MIT, local, national and global communities. While launching new programs, the PSC successfully maintained and expanded its ongoing events and programs, including CityDays, Science Expo, Giving Tree, Freshman Urban Program, LINKS, KEYs, CommuniTech, ReachOut: Teach a Child to Read, and Public Service Fellowships. For example, our well-established Public Service Fellowship program has been expanded to include additional opportunities for work-study students, and it has also been diversified to include more national and international opportunities as well as varied local service activities of interest to the community and to MIT students.

New partnerships and enterprises were established this year with Boston Public Schools, Tutoring Plus of Cambridge, Rockport Public Schools, the MIT Museum, the Sloan School of Management and the Edgerton Center. Several of these enterprises have already received grant support. For example, the PSC-Edgerton partnership received grants from Massachusetts Campus Compact, the d'Arbeloff Education Innovation Fund, and the Lemelson Foundation to support service learning and the IDEAS Competition. The PSC also received a Massachusetts Campus Compact grant to begin the MultipliCity program with Tutoring Plus of Cambridge to enhance multicultural understanding and academic support for economically disadvantaged children. A successful pilot science mentoring program developed with Boston Public Schools, TechBoston, and Massachusetts Pre-Engineering Program was just awarded a $10,000 Siemans grant.

Service learning at MIT was expanded this year with 18 participating classes, and resources were established to support the program's growth. MIT service learning offerings were available in the form of Public Service Design Seminars and Freshman Advising Seminars, as well as in existing classes. This coming November, the PSC will report on MIT's innovative approach to service learning at the Frontiers in Education Conference and will host an engineering service learning workshop for faculty throughout the New England region.

An exciting extension of service learning, the IDEAS Competition, also was successfully begun. This new competition challenges students to develop their creative design ideas for projects that address community needs. Project implementation awards totaling $22,000 were awarded to the winning teams, which will work on projects pertaining to global water quality and environmental safety issues, education, and health.

The PSC works closely within the campus community as well as externally. In collaboration with the Undergraduate Association and the Graduate Student Council, the PSC ran a September 11 Disaster Relief Fund Drive, raising $23,000 for American Red Cross Disaster Relief. The PSC's ties with the MIT community are also being supported through a new and expanding website at http://web.mit.edu/mitpsc/, as well as through service leadership awards and monthly dinner meetings with leaders of student service groups. As well, The Coop, which created a student service grant for $10,000 last year, increased the amount available to $15,000 this year. The PSC also offers grants to support students' service projects throughout the year.

Residential Life Programs

The academic year 2001–2002 encompassed many new initiatives, including the first full year of the Residential Life Programs (RLP) section within Student Life Programs. The office moved from Room W20-549 to Burton-Conner in August to accommodate the addition of five new staff positions (four residential life associate (RLA) professional positions and one support staff). This was a year of transition—both in terms of integrating the RLA program and working with the Residential System Implementation Team to prepare for fall 2002 and freshmen on campus. RLP also provided increased support for graduate students and families, housemasters, graduate resident tutors (GRTs), and student residents through a number of initiatives.

In August of 2001, the residential life associate program was instituted with the hire of four new professional staff. The RLA program was mapped out in zones on campus, with graduate and undergraduate residences sharing RLA staff. Over the first year, the program focused on learning the MIT culture and in particular, the culture of each residence. A six-month review was conducted to evaluate the program and RLAs were evaluated for their own performance. In the spring of 2002, we made a decision to enhance and change the program for next year: two additional RLAs will be hired and separate zones for undergraduate and graduate residences have been developed to enable RLP to better meet the needs of each population.

Now in its second year, the residence-based advising program, a collaborative program with the Academic Resource Center of DUE and the Health Education Service of MIT Medical, expanded to three residences: McCormick, Random, and Next House (new to program). The RLAs played a primary role in overseeing and working with the resident associate advisors. The current plan for fall of 2002 is to greatly expand the program in Next House with 19 RAA's and the McCormick program will hold steady at eight RAAs. The Random Hall program will be phased out, as it was not deemed a success. Residential Life Programs, through the RLAs, will provide more enhanced training and oversight into the next year.

In the winter of 2001–2002, a committee was convened to look at the roles and responsibilities of the graduate resident tutor at MIT. The committee report is forthcoming later this summer and will address a variety of issues which have in the past been neglected or not in writing. With the addition of 10 GRTs for Simmons Hall, we had an all-time high of 30 vacancies to fill for this coming year. With a strong recruitment period, we had 71 applicants, and moved three existing tutors to Simmons Hall. Tutor trainings were held throughout the year, but a more focused and routine training is needed for the upcoming year. The Tutor Advisory Board, made up of one tutor from each residence hall, was established to help support and advise Residential Life Programs on tutor training issues.

In September of 2001, Residential Life Programs set up a satellite office of Student Activities Finances to align financial processing and support for residence halls with the new advising structure provided by the RLAs. In addition, financial support and training for housemasters was enhanced, including a new system for handling GRT finances. Through the new system, GRTs are treated much like student organizations, increasing reimbursement turn-around significantly and reducing time spent by housemasters on financial processing. With the Institute decision to close all outside bank accounts, increased staffing in Student Activities Finances, and the intended relocation of the core Residential Life Programs staff to Room W20-549 after the Public Service Center moves to Room 4-104 this coming fall, a decision was made to reconsolidate all student financial functions, including GRT accounts, to Student Activities Finances. Housemaster finances will still be supported through Residential Life Programs.

Student Activities Office

The Student Activities Office (SAO) formally became the advisor to the Freshman Leadership Program this year and built relationships with the student coordinators, which will ensure a quality program in the future. In addition, the staff's ongoing work with the Graduate Student Council (in conjunction with the Graduate Students Office and the Office of Organizational Development) led to the creation of a leadership development program specifically for graduate students, the first of which was held this past September. SAO also provided direction and support to the second annual Undergraduate Association (UA) Councilor Retreat held in September and coordinated the first-ever ASA retreat which helped the 10 student committee shift its focus from increasing the number of student organizations on campus to providing more quality service to existing student organizations.

Programmatically the office had a successful year as well. Fall Festival was a major success this year with several hundred students attending a carnival on Kresge Oval. Additionally, due to increased staffing in SAO, each of the Class Councils was appointed a specific advisor this year, which led to more effective programming. LeaderShape, now in its eighth year, was again a great success. Sixty-five students participated in the program and 13 faculty, staff and students served as facilitators. Spring Weekend 2002 included a concert by Sugar Ray, which sold 2,300 tickets. About 300 students came to the barbecue and "Class Wars" events on Saturday and the weekend. The ninth Charm School was also organized. An estimated 800 students attended the 28 different classes taught by over 50 faculty,

students, and staff. And finally, SAO hosted the second annual Student Leaders Reception for all organization presidents and treasurers as a way to provide more visible celebration and recognition of student leaders.

The Student Activities Office also addressed a number of important issues facing student organizations. We increased the visibility of our services and clarified our role and relationship with the Campus Activities Complex (CAC). Working with the Treasurer's Office, we have been implementing the Institute-wide initiative to discontinue the support of outside bank accounts effective July 1, 2002. Working with the Association of Student Activities and Athletics, Physical Education, and Recreation (APER), we addressed the overlap that was creating funding, risk management, and oversight issues for some APER-related student organizations. A clearer definition was developed for these groups to move recognition for any organization that is athletic and competitive and/or instructional in nature to APER as a club sport. Finally, a committee consisting of student organization leaders, Campus Police, SAO, and CAC reviewed the metal detector event policy, resulting in a requirement for student organizers to meet with CAC, SAO, and Campus Police at least two weeks prior to the event.

Supplemental Funding Allocation

Student Life Programs, primarily through its Student Activities Office, continues to coordinate the dissemination of a significant amount of funds to student organizations and programs. Through this year's Institute budget process, a proposal was developed which resulted in an increase, by several $100,000s, of funding for student initiatives, including the Large Event Fund, Class Councils, and a newly created Cultural Diversity Fund.

This year, Weekends@MIT distributed $40,000 to 16 individual events sponsored, at least in part, by one or more living groups, including the Infinite Buffet, Fall Festival, Chinese New Year, and Comedy Collage. An additional $40,000 was allocated through the MIT Fund to 27 different groups/programs, with the largest allocation being $3,000 for any one program, and the Student Activities Discretionary Fund allocated $36,400 to 25 different events, groups, or programs. And finally, the "Student Life Now" Fund began the fiscal year with $12,230 on July 1, 2001, with an additional $11,618 in gifts made this year by parents; $19,300 was allocated to support 12 different programs and events this year.

Staffing Changes

Anne and William McCants will be stepping down as housemasters of Green Hall after more than a decade and, for personal reasons, have selected not to become the new housemasters of Simmons Hall. John and Ellen Essigmann, after seven years as housemasters at New House, will move to Simmons Hall when it opens this August. The Essigmanns will be joined by associate housemasters Muriel Medard and her husband John Simmons. Wesley and Sandra Harris have been appointed as the new housemasters of New House. Roger and Dorothy Mark will be the inaugural housemasters this fall in Sidney and Pacific, the newest graduate hall, and will be joined by associate housemasters Keith and Brenda Hampton.

Anthony Gray, Chandra Mincher, Aaradhana Prajapati, and Gabrielle Pardo were hired as the first residential life associates, each supporting a zone of several graduate and undergraduate residence halls.

Linda Noel was hired as the program coordinator for student activities. Fran Miles was hired as assistant to the associate dean and director of SLP. Kari Enge was hired as the program assistant for student activities.

Jennifer Johnson, program assistant for FSILGs, recently announced her resignation and Laura Martin will replace her effective mid-July 2002. Denise Vallay was promoted into an administrative staff position in Housing. Lisa Walsh resigned as operations coordinator for FSILGs. Nathan Elton, program assistant for residential programs, also resigned this year. Marie Shanahan moved to a new position of senior office assistant to support the residential life associate program. Due to a reorganization of the office, the position was eliminated and Marie elected to leave the Institute.

Barbara A. Baker
Associate Dean for Student Life Programs

Chair of the Faculty

Faculty Policy Committee

In 2001–2002 the Faculty Policy Committee (FPC) oversaw those aspects of educational and academic policy that are the specific responsibilities of the Faculty, and provided faculty input toward policy development at the Institute. This year the committee met twice with the president and used these opportunities to convey faculty opinions on a variety of topics, including campus security and other campus responses to September 11, faculty quality of life, status of the capital campaign, faculty diversity, and family leave policies for faculty.

The FPC heard from and reviewed the work of several faculty committees and task forces. This included updates from the MIT Mental Health Task Force, the Council on Family and Work, the Task Force on Campus Security, the Committee on the Protection of Human Life and Infrastructure, and the Committee on Access to and Disclosure of Scientific Information. The FPC met with members of the Committee on the Library System to review the proposal for a new library; similarly, the chair of the Committee on Faculty Administration (CFA) came before the FPC to discuss the CFA's work on exploring the feasibility of a new faculty club. The FPC met with the chair of the Committee on Student Life to discuss community building at MIT. The FPC met twice with members from the Council on Faculty Diversity; first to review the council's proposed family leave policies for faculty, and second, to discuss the council's efforts and plans regarding faculty hiring.

The FPC approved a resolution on the importance of undergraduate mentoring, which was brought forward by the Committee on Undergraduate Program. The faculty approved the resolution in May.

The FPC reviewed a name change from the Division of Bioengineering and Environmental Health to the Division of Biological Engineering, and reviewed the dual master's degree program being offered jointly by the Harvard-MIT Division of Health Sciences and Technology program (HST) with the Management of Technology program (MOT) at Sloan.

In the fall of 2001, the FPC considered the proposal to re-charter the Committee on Student Affairs (CSA). The proposal reflected a desire to reinvigorate the CSA by expanding and clarifying its charge and to realign the Faculty committee structure with the reorganization of the dean's office into two areas—the Office of the Dean for Student Life and the Office of the Dean for Undergraduate Education. As a result, the FPC approved renaming the committee to the Committee on Student Life, and changes were made to Section 1.73.6 of the Rules and Regulations of the Faculty. These changes were brought to the September Faculty meeting and were approved by the Faculty in December.

Professor Graves, who chaired the *ad hoc* Committee on the Faculty Newsletter, invited its other members to speak with the FPC. The *ad hoc* committee was charged with reviewing the need for a newsletter, its staffing and organization, and what kind of improvements, if any, the newsletter might have in the future. They discussed these issues with the FPC, as well as with the Faculty Newsletter editorial board and other members of the MIT community. The *ad hoc* committee delivered its report to the president in May.

Committee on the Undergraduate Program

Mentoring Undergraduates at MIT

Building on the activity started by the Working Group on Undergraduate Advising during 2000-2001, the CUP devoted a substantial portion of its meeting time this past year to review undergraduate advising initiatives and to shaping its statement, "Mentoring Undergraduates at MIT," in collaboration with the Committee on Student Life. This preliminary report, presented to the Faculty in December 2001 (see http://web.mit.edu/committees/cup/mentoring_undergraduates.html). recommended "the Institute begin the process of developing a more effective approach to the advising of undergraduates through the development of '"mentoring networks."

CUP chair Kip Hodges, asked for a sense of the Faculty to confirm the role that mentoring plays in the lives of undergraduates. The Faculty endorsed the CUP report in May 2002 and has directed the committee to "develop a comprehensive plan for the design and implementation of new undergraduate mentoring guidelines in collaboration with the Office of the Dean for Undergraduate Education and the Committee on Student Life." These guidelines will be developed and presented to the Faculty in the next academic year.

Subcommittee on the Communication Requirement

Developing and approving Communication Intensive Subjects in the Major (CI-M) was the major focus of the CUP's Subcommittee on the Communication Requirement (SOCR) during 2001–2002. Based on input from the committee, the SOCR co-chairs, Professors Suzanne Flynn and Paul Penfield, worked closely with the undergraduate officers in each department to identify and develop appropriate CI-M subjects for each undergraduate major. These subjects must provide instruction and practice in the modes of communication appropriate to their disciplines. SOCR members reviewed and approved 115 subjects for designation as CI-M for MIT's 53 undergraduate degree programs. CI-M subjects will include laboratory classes, in which students write, revise, and present laboratory reports;

seminars, in which they prepare and lead discussions; and senior theses and independent research projects. After being reviewed by the SOCR for content and structure, the CI-M subjects were forwarded to the Committee on Curricula for final approval.

In the spring, the SOCR further reviewed the CI-M subjects for pedagogical effectiveness, their administrative feasibility, and the fiscal responsibility before making recommendations on resource needs to the dean for undergraduate education. The subcommittee considered several policy issues and established procedures for approving substitutions to CI-M subjects and CI-M subjects for individually tailored undergraduate programs, and a process for handling petitions seeking retroactive CI-M credit. The SOCR reaffirmed the policy outlined the previous year regarding CI-M subjects for double degrees. The SOCR is charged with interim responsibilities related to the transition from the Writing Requirement and, in this capacity, considered several petitions from students regarding completion of this requirement. Members engaged in preliminary discussions regarding the assessment of the Communication Requirement and will focus more closely on this process during the coming academic year.

The CUP reviewed the recommendations of the CUP Subcommittee on Pass/No Record Grading regarding the five-year experiment that will introduce "exploratory subject" grading options for second year students. Following a discussion that provided new members with the original goals of the proposed experiment and some of the issues associated with implementing the experiment as proposed, the CUP revised the terms of the experiment in a way that preserved the original intent but that also facilitated its implementation.

CUP business in other areas included the following:

—The CUP heard about the Undergraduate Practice Opportunity Program (UPOP), a new program in the School of Engineering that is a summer internship opportunity for upper-class engineering students, designed to provide professional skill building.

—The CUP reviewed the traditional policies regarding undergraduate degree-granting units in anticipation of a proposal from Comparative Media Studies (CMS) to offer the first interdisciplinary undergraduate degree at MIT. Following the presentation by CMS in December, the CUP drafted a set of general guidelines regarding approval of interdisciplinary degree programs. These guidelines were forwarded to the Committee on Curricula for consideration along with the CUP's endorsement of the proposed CMS undergraduate degree program.

—Throughout the year, the CUP heard progress reports on a number of pilot projects designed to improve the first-year experience and supported by d'Arbeloff Grant resources. Project reports were provided by individuals involved with the BioMatrix mentoring program, the freshman residence-based pilot programs, and faculty involved with a number of initiatives in mathematics. The review of the advising initiatives was undertaken during a joint session with the Committee on Student Life.

The CUP reviewed the report and recommendations of the Department of Materials Science and Engineering regarding the future status of the experimental SB degree in archaeology and materials (III-C). The III-C degree has been an undergraduate degree option within the department since the fall term of 1998. Based on its review of the program, the department has recommended that the III-C option be continued on a non-experimental basis. CUP members supported this recommendation, although there remained reservations about whether degree programs of such small size should be allowed to exist indefinitely, particularly if departmental support diminishes over time. The CUP has made recommendations to the COC on this matter.

Professor Deborah Fitzgerald chaired the Committee on Academic Performance (CAP), which reviewed 507 student petitions during 2001-2002, a 10 percent increase from the previous year. The largest category of increase was in petitions to late-drop a class (from 136 to 228). Fewer students attempted to change from grades to/from P/D/F, or to exceed their warning credit limit, which may indicate that students are learning that such petitions are not often granted. Due to a change in leadership, more petitions were taken to the committee than last year.

The end-of-term actions taken by the committee were largely consistent with actions last year. The committee put 329 students on warning, the majority of them freshmen (131). Warnings were distributed to the different classes in much the same ratios as last year, but for a second year sophomores received fewer warnings than two years ago, when the figure was 104. Students who were required to withdraw numbered 32, down from last year's 38. Compared to the previous year, more seniors (nine versus six), fewer sophomores (six versus eleven), and fewer freshmen (six versus nine) were required to withdraw.

End-of-Term CAP Actions (by Class Year)

	2001–2002		2000–2001	
	Warnings	Required Withdrawals	Warnings	Required Withdrawals
Year 4	57	9	50	6
Year 3	61	11	69	12
Year 2	80	6	74	11
Year 1	131	6	137	9
Totals	329	32	330	38

The committee worked with the SOCR and the CUP to figure out how to administer two new initiatives that will affect the CAP next year: the SHASS-CI requirement, and the sophomore exploratory subject. Because of the timeframe requirements of the CI requirement, the CAP agreed to put students on warning who do not make adequate progress towards completing this requirement by the third semester. Concerns about grade shopping and petition overload led to the CAP's request that students designate their sophomore exploratory subject only in the first week of the term, and that such decisions not be petitionable except in dire circumstances. This seems in keeping with the spirit of the initiative, and will reduce possible pernicious side effects.

The committee also discussed the shift from P/NR to A/B/C/NR for freshmen. Because the number of freshmen who are possible candidates for required withdrawal is very small, the committee felt that the number of students who might be placed on a second term of P/NR would also be small. After discussion, the committee was of the opinion that extending P/NR to freshmen who did poorly in fall semester next year would probably do more harm than good. All three of these initiatives will be implemented in 2002-2003.

The Committee on Corporate Relations (CCR), chaired by Professor Arthur B. Baggeroer, continued to examine the possibilities for changing its charter following discussions last year with the Faculty Policy Committee (FPC). There was consensus that the current charter for the committee was no longer appropriate. After examining several possibilities, the CCR recommended that it be disbanded. The chair of the Faculty will appoint a member of the FPC to maintain contact with the Office of Corporate Relations as needed. The appropriate modifications to the Rules and Regulations of the Faculty were voted on at the May Faculty meeting.

The Committee on Curricula (COC) approved proposals for new, canceled, and revised subjects, including 103 new undergraduate subjects, and was responsible for approving substantive curricular changes and upholding policy. This year, much of the committee's work centered on approving and implementing the new Communication-Intensive Major (CI-M) subjects. With the Subcommittee on the Communication Requirement, the COC approved 109 CI-M subjects.

In reviewing CI-M subjects for Course 5, the COC requested that the Chemistry Department reevaluate the required units for subjects 5.32 Intermediate Chemical Experimentation, and 5.33 Advanced Chemical Experimentation. The request was based on student evaluations indicating that they spend more than the required number of hours on these subjects. The reevaluated subjects will be reviewed by the COC next year.

The COC approved substantive changes to the undergraduate curricula in Course 10, Chemical Engineering; Course 13, Ocean Engineering; Course 22, Nuclear Engineering; and Course 8, Physics. The committee reviewed and approved the new School of Engineering Undergraduate Practice Opportunities Program (UPOP), and approved a new interdisciplinary minor in astronomy. Using the established criteria for interdisciplinary minors, the committee requested that existing subjects be modified to join the concepts of the various disciplines. The committee also approved a new SHASS minor in Chinese.

The committee worked throughout the spring to consider a proposed interdisciplinary major in Comparative Media Studies. The committee considered how the approval of a new interdisciplinary major might impact future proposals for similar majors. The committee expects to establish guidelines and criteria for interdisciplinary majors.

The COC reviewed student petitions to pursue second SB degrees, and for substitutions to the General Institute Requirements. The committee is working to establish one contact in each department to review second SB petitions.

In order to abate petitions for second SB degrees from MEng graduate students, the committee requested that Course 6 inform these students of the deadline for filing petitions; students must file a petition to the COC immediately upon acceptance into the MEng program, and at least two terms before they intend to receive their first SB degrees. Petitions submitted by MEng students during the fifth year will not be considered by the COC.

The Committee on Discipline held hearings against nine students on charges of plagiarism, cheating in requesting re-grading of work, and embezzlement. The respondents were five men and four women; three sophomores, two juniors, and four seniors; neither graduate students nor freshmen were included. The sanctions imposed included formal probation for two or three years, suspension for one semester, suspension for seven years, and expulsion.

In addition, faculty members sent the Office of Student Conflict Resolution and Discipline warning letters for 25 students, creating a record of their academic misconduct, in case of future misconduct, but not initiating disciplinary action against them for the current incident.

There appears to be reluctance among the faculty to bring charges against freshmen and a prevailing willingness to give them one more chance. Of the upperclassmen charged with academic misconduct, 75 percent received warning letters and 25 percent faced hearings, while all of the freshmen received warning letters.

The Harold E. Edgerton Faculty award is given to an outstanding member of MIT's junior faculty. The selection committee awarded the Edgerton Prize to Professor

Peter H. Seeberger in recognition of his fundamental contributions to the sciences of biochemistry and synthetic organic chemistry. His work holds enormous promise for the development in the future of vaccines against a number of infectious agents, more specifically those causing parasitic infections. Dr. Seeberger began his attack on the problem of the synthesis of complex oligosaccharides as a postdoctoral fellow at the Sloan-Kettering Institute in New York and continued this research agenda after his arrival as an assistant professor at MIT in 1998.

While piloting this extraordinary research and development effort over the past four years, Dr. Seeberger has played a significant role as lecturer in the classroom and mentor of doctoral students. He has taught a wide range of undergraduate and graduate courses in the Chemistry curriculum and been recognized for the high quality of his teaching. Beyond this, he has developed a new course, Bioorganic Chemistry, which draws in part from his own research and from the new research field in which synthetic organic chemistry is used for the creation of a wide range of biological molecules. It is for these many reasons that the MIT faculty recognizes Dr. Seeberger's achievements over the past four years by conferring on him the 2002 Edgerton Award.

The Committee on Faculty Administration (CFA), chaired by Professor Ronald Latanision, extended its deliberations on the concept of a renewed faculty/community club. With shared fiscal commitments from all of the academic deans and the president, an architectural firm and a hospitality planner will undertake a feasibility study during the summer of 2002. The club concept includes fine dining for faculty and staff, provisions for social activities and professional meetings, conference facilities, and overnight guest accommodations. With appropriate service, a central location on campus, and planning, it is anticipated that an operationally self-sustaining club could be developed. The club is expected to add to the quality of life among the faculty, as well as to build a sense of community at MIT among professional colleagues. Finding suitable space and capital for renovation/construction are obvious challenges, and discussions will continue during the fall semester of the 2002-2003 academic year.

The committee to select the James R. Killian, Jr., Faculty Achievement Award for 2002-2003 sent out a call for nominations in December 2001. It reviewed 11 nominations submitted over the past three years (many of them updated) and one new nomination. This year, the award was presented to Professor Ann Graybiel, Walter A. Rosenblith professor of neuroscience in the Department of Brain and Cognitive Sciences. The committee members unanimously chose Dr. Graybiel from the 11 nominees because they felt strongly that the top-level research she is doing is some of the most interesting and important work being carried out at the Institute. Ann Graybiel's research focuses on normal and abnormal behaviors associated with the basal ganglia and their relationships to dopamine regulation. Disorders in this region have been implicated in Parkinson's and Huntington's diseases, and in neuropsychiatric disorders such as Tourette's syndrome, obsessive/compulsive disorder, depression, and also addiction.

The Committee on the Library System (CLS) studied the MIT Libraries in the digital age and how the libraries can improve the quality of student life. The report results identified the severe lack of library space as a serious impediment to education and research at MIT. The committee's report discussed the role of well-designed and contemporary library facilities in enhancing the productivity of faculty and students. Such facilities serve as centers to create, manage, use, and share information; they support new educational technology; they prepare students for life-long learning; and they provide services to users with disabilities.

Digital technology will not reduce the need for library space in the near future because of a variety of issues including changing hardware standards, vendor instability, copyright and licensing requirements, the library's archival responsibility, lack of acceptance of electronic books, the need for space to browse, to study, and obtaining librarian help in proximity to library materials. The report recommended the construction of a new combined Science and Engineering Library and the renovation and expansion of an integrated Humanities and Social Science Library in Building 14. The Academic Council, the Undergraduate Association, the Graduate Student Council, the Library Visiting Committee of the Corporation, and the Faculty Policy Committee supported the recommendations of the report, and the next phase in planning will include conversations with the MIT community.

Other notable subjects discussed include: the report of the SHASS *ad hoc* committee on the Humanities Library; the Libraries' budget and the support for electronic resources and new educational and research program needs; outreach to alumni through library services; an update on the DSpace project; and the support needed from the Committee for the Review of Space Planning for critically important short-term facilities improvements. These improvements might include the renovation of the Institute Archives, a renovated preservation center in the Libraries, and construction during the summer of 2002 of a 24-hour study space for students in the Hayden building.

This spring, the Committee on Nominations persuaded seven of our colleagues already serving on our standing Faculty committees to extend their terms by a year or two for enhanced continuity, and otherwise it recruited another 32 colleagues, including 10 who had never served on any of these committees, as fresh nominees.

In addition, we were very pleased to recruit Professor Rafael Bras as the next chair-elect of the Faculty in the year 2002-2003. Professor Bras will assume the main role in 2003 once Professor Stephen C. Graves concludes his term. All these nominations were confirmed at the May meeting of the Faculty.

Paul Lagace continued as chair of the Committee on Student Affairs/Life (CSA/L). The committee's motion to re-charter was approved by the Faculty in December and the committee's name officially changed to the Committee on Student Life (CSL).

The committee served as a source of reflection and input for other Institute groups and offices dealing with issues related to student life. Of particular note are the following:

- The committee worked with the Mental Health Task Force as they issued their final report.
- The chancellor sought the input of the committee as issues associated with crowding in the undergraduate dormitories were considered while plans continued for the 2002-2003 academic year.
- The Institute Dining Board came to the committee to report on their findings and to get input from the committee.
- Several Institute community members brought to the attention of the committee that numerous faculty members violate the intent, if not the letter, of the rule concerning having no required academic exercises during the 5–7 pm time period. The committee undertook this issue and drafted a letter to be sent to the faculty and worked with the chair of the Faculty on this. The CSL is working with the CUP to finalize this document before bringing it to the chair of the Faculty.

The committee drafted a white paper on "Community" and shared this with Institute leaders including the chancellor, the dean of graduate students, the dean of undergraduate education, the Faculty Policy Committee, and the leaders of the Undergraduate Association and the Graduate Student Council. A small subgroup of the committee is finalizing the changes to the white paper over the summer.

Housing dominated much of the agenda of the Committee on Undergraduate Admissions and Financial Aid (CUAFA) this year. As members of the Enrollment Management Group, CUAFA representatives expressed concerns that the overcrowding of undergraduates, most of whom are freshmen, was having a negative impact on yield. Accordingly, the CUAFA offered strong support of the decision to eliminate crowding in the coming academic year. Housing factored prominently in the decision to reduce the size of the incoming class to 1,000, a number that includes transfer students.

In spite of the administration's injection of funds last year to allow a reduction in the self-help level by ~$2,000, some of our peer institutions have also intensified their efforts, with the result that MIT remains at risk of not being able to attract top students from families with incomes in the $50,000–$100,000 range. The CUAFA's recommendation that the self-help level be reduced another $700 to $4,900 was not acted upon. The impact of this decision on the demographics of our entering class will be studied.

Lastly, the committee observed that little has been done to improve the offices of Student Financial Services, in which the space remains inadequate. In particular, the staff offices are incapable of seating a typical family for a private discussion of delicate financial matters. The CUAFA is concerned about the possible negative impact on our yield and the dispiriting effect on morale of Student Financial Services staff.

This admissions cycle saw a reduction in yield to 57 percent, which represents the third consecutive year with a 1 percent drop. Another negative trend is the drop in yield among those offered financial aid. This cycle the yield for this group was 58 percent, a mere 1 percent enhancement over the yield as a whole. In the past this differential has been as high as 8 percent. The CUAFA will participate with the Admissions Office and the Financial Services Office in conducting a study to understand the reasons for the observed trends.

Stephen C. Graves, Chair of the Faculty
Lily Burns, Staff Associate

Executive Vice President

Highlights

Program Review

In last year's report, the provost and I announced the initiation of a program to review central administrative areas, modeled in part on MIT's highly successful Visiting Committee approach in academic departments. In April of 2002, we completed our first pilot reviews: Information Systems and Financial Systems Services.

Trustee James Champy and director of MIT Libraries Ann Wolpert co-chaired the internal review committee comprising faculty and administrators chosen for the depth of their information-technology knowledge as well as the variety of users they would represent across MIT. James Champy also chaired an external review committee comprising many of the best university chief information officers, as well as experts from outside higher education. We are in the process of reviewing the committees' reports with the two pilot units, and will report more broadly the actions we will take in response.

The review identified areas for service improvement; the need for clearer priorities governing, and better coordination among, our information technology purveyors; areas where we lead and those where we lag current technologies and services; and the need to address economies of structure and scale. At this point, we can declare the pilot a success and will work through other areas in the coming years. Seeing ourselves as others see us is vitally important.

Financial Performance

The Audit, Budget, and Controller's Offices joined their efforts to produce quarterly financial statements for the Institute, and began pilot engagements with operating units across the campus to assess financial performance on a regular basis within fiscal years. The ability to predict issues early which may require management interventions is crucial to the financial well-being of MIT.

Capital Construction

This has been an intense year for our Capital Projects Group in Facilities. Six projects are under construction, ten in design, and many others under study. The graduate dormitory at 224 Albany was finished, and is enormously popular. From June 30, 2002 we could see our way towards opening three more projects in August: the Zesiger Sports and Fitness Center, the Simmons Hall undergraduate residence, and the Sidney and Pacific graduate residence. The capital phase of the Student Life and Learning agenda is nearing completion! Phase 1 of the Dreyfus Chemistry Building renovation was completed as well.

Environmental Health and Safety

The Environmental Health and Safety Office consolidated its five programs in one location, allowing for both greater collaboration among staff and more effective delivery of services to clients. Major work has begun on the development of the EHS Management System with significant input from community members in the departments, labs, and centers. Also, Academic Council adopted an EHS policy for MIT in December 2001.

Human Resources

In other systems news, many departments under the executive vice president have been collaborating on both the Human Resources-Payroll project and Lincoln Lab's Enterprise Resource Planning/SAP project. The SAP benefits module began to be used by Benefits Office staff in July 2001, and it was extended in November to support the annual benefits open enrollment. Module by module, we are consolidating a hodge podge of home-grown software applications into one integrated enterprise product.

Research

On the regulation front, a significant development over the past year has been the increased focus of federal agencies, particularly the National Institutes of Health, on issues of compliance. There are new requirements for protecting humans as subjects, and the government also is moving toward more detailed financial disclosures for both individual and institutional conflicts.

Personnel

John DiFava, formerly the colonel/superintendent of the Massachusetts State Police, joined MIT as its new chief of police.

Steve Dimond, manager of MIT's Copy Technology Centers, was one of the recipients of the 2002 Billard award for outstanding service to the community.

Personal and Professional Activities

I was appointed chairman of the board of the Forum for the Future of Higher Education, which moved its affiliation from Yale University to MIT, and also became chairman of the Trustee Finance Committee of the College Board. Educause published my article "The Organizational Challenge: IT and Revolution in Higher Education" in its anthology Web Portals and Higher Education: Technologies to Make IT Personal; the article was also featured in the March-April 2002 issue of Educause Review.

John R. Curry
Executive Vice President

Audit Division

The Audit Division delivers audit services through a risk-based program of audit coverage including compliance assessments and financial, operational, and technology reviews and audits. These efforts, in coordination with the Institute's external auditors, provide assurance to management and the Auditing Committee that good business practices and policies are adhered to, adequate internal controls are maintained, and assets are properly safeguarded.

Fiscal year 2002 saw the Audit Division's transition to a fully staffed function, operating around four functional teams responsible for distinct areas of the Audit Plan: Financial and Compliance Review, Operational Audit, Information Technology Audit, and Construction Audit. Information Technology audit resources provide support to the other teams, thereby integrating systems expertise into examination of business processes. Of special note, effective this year we established a new function, Professional Standards and Strategy, promoting an experienced member of the audit staff to associate audit manager to lead it. Working with the Institute auditor and the audit manager, this new function guides the division in setting policy and direction to help us achieve our long-term goal of becoming MIT's world class audit function.

The Audit Division's scope of services is equal to the full extent of MIT's auditable activities. Allocation of audit resources across this broad spectrum is accomplished via a model for evaluating risks associated with individual units and/or operational processes, thereby determining a cycle of audit review. The resulting annual Audit Plan guides the assignment and completion of work, which is heavily biased (approximately 30 percent of audit resources, measured in available staff hours) toward assuring compliance with financial controls and requirements of research sponsors within individual academic, research, and administrative units. Audit review of capital construction projects has become an increasingly important part of the plan (approximately 10 percent), with remaining time devoted to audits and review of operational processes, uses of technology, and special projects. Time is also specifically allocated to staff development.

During the past 12 months, we evaluated the adequacy of compliance with Institute guidelines, policies, and procedures, for control over financial activity throughout the School of Engineering. Of particular interest was measuring this area's adaptation to new guidelines for financial review and control, promulgated in 2001. Isolated exceptions, correctable in the normal course of business, were addressed to individual departments, labs, or centers, and we are collaborating with the dean's office in identifying areas for targeted education and oversight. A concurrent audit effort, examination of practices in the administration of sponsored research in the School of Engineering, is nearing conclusion.

Operational controls were examined in several areas, including MIT Dental Services, the Lincoln Lab Fiscal Office, General (non-sponsored) Accounts Receivable, Resource Development, and MIT Athletics. In addition, the operations of the Institutional Review Board and the Committee on the Use of Humans as Experimental Subjects were examined for the first time. Finally, of particular note, several members of the Audit Division, in collaboration with staff from the Controller's Accounting Office, assisted the MIT Press in planning and conducting a full physical inventory of approximately 1.5 million books with a value in excess of $5 million.

From time to time the Audit Division takes on special reviews that are initiated at the request of senior management, or in recognition of changing circumstances or situations that pose unusual risk to the Institute. In January 2002, the executive director of the Media Lab requested an independent review to assess the financial condition and related accounting controls of the Media Lab. The ensuing review was conducted by resources retained from PricewaterhouseCoopers, under the direction of the Institute auditor, and was completed in June.

Construction audit activities have focused on multiple capital projects, representing nearly $800 million in project costs. These reviews seek to verify that all costs to the Institute are legitimate, complete, and appropriate in accordance with the final contracts and all related change orders. Reviews have identified potential recoveries and questioned costs of approximately $1.6 million, of which approximately $800,000 of cost reductions have been negotiated by management with the contractor. The construction audit process employs the services of several external audit firms, with both local and national presence. Selection of firms is based upon prior experience with the Institute and the project's construction management, in a competitive bidding process. The division's construction audit specialist consults regularly with project managers on the status of projects, and to identify areas of potential exposure that may be avoided contractually or with modifications in practices.

Our information technology specialists have been welcome additions to several endeavors on the technology front, including involvement in the SAP HR-Payroll module implementation, and the Lincoln Lab SAP Financial, Purchasing, Plant Maintenance, and HR-Payroll implementations. In addition to adding value to these development projects, this group has completed a review of controls in the Data Center, and also over local area networks employed in three labs and centers. Also, a follow-up review of compliance with the Institute's new e-commerce policy was recently conducted.

In addition, we have actively participated in the Environmental Health and Safety initiatives that are being undertaken in connection with the consent decree with the US Environmental Protection Agency and the Justice Department. This commitment will continue to grow in the upcoming year, as the division's audit manager is leading the team responsible for design, development, and implementation of the audit component of the Environmental Health and Safety Management System. Involvement by Audit in this and the above systems development projects demonstrates the division's willingness to foster positive change as part of a management effort, in addition to fulfilling the traditional role of independent assessor.

Owing to considerable success in recruiting activities, the division's operations were less severely impacted, compared to prior years, by unfilled positions throughout this period. This diminished the need to draw on outside resources to fulfill the obligations of the audit plan. To gain access to expertise not available from our permanent resources, we did, with the support of executive management and the MIT Auditing Committee, selectively retain contract help to assist with work in MIT Dental Services, MIT Athletics, and the Media Lab, as well as to carry out our construction audit program. For this reason, we maintain relationships with various strategic partners who provide audit services, should the future need arise.

The division continues use of a software package enabling automation of administrative aspects of the audit process (work papers, scheduling, time tracking, and record keeping of audit findings). This not only brings the division to a peer level for automation, but it also provides the foundation for "industrial-strength" measurement, monitoring, and reporting to the MIT Auditing Committee on status and results of the Audit Division's activities.

The role of audit committees in both public and not-for-profit organizations is being better defined by members of the audit profession and others taking a strong interest in matters of institutional governance. The MIT Auditing Committee officially expanded their annual meeting schedule to three meetings, to permit additional time for topics of interest in concert with their mission. The committee also adopted a charter that will lend momentum to the Audit Division's goals for monitoring internal controls and supporting the Institute's risk management processes, as well as formalize the committee's operations and obligations.

We emphasize professional development on the part of all our staff. During the past year we are pleased to note that one of our staff, William H. Connelly, successfully passed the first of four portions of the examination necessary to becoming certified as a certified internal auditor. This marks substantial commitment to the profession of internal auditing on the part of this individual. Members of the Audit staff find opportunities for training in their discipline, and affiliate with industry peers through conferences, seminars, and group meetings. The Institute auditor is a member of the "Little 10+" association of Ivy League and other peer institutions, which meets semi-annually. The Information Technology audit team all participated in a similar program of IT audit peers. The Institute auditor was also selected to be a fellow in the pilot effort for a newly launched leadership development program, "Leader to Leader," uniquely designed for leaders in the MIT community. This ten-month program concluded in June 2002.

The Institute auditor is an active participant in several management groups. As a member of the executive vice president's senior management team and the Administrative Systems and Policies Coordinating Council, the Institute auditor lends expertise in risk management and control in addition to staying abreast of new developments in broader Institute initiatives. The Institute auditor has also recently joined the Budget and Finance Steering Group, to provide an additional link between internal operations and the oversight activities of the Auditing Committee in financial affairs of the Institute.

The Institute auditor also chairs the Central Authorizer (CA) Oversight Committee, which works with the Business Liaison team in their dual capacity as the "Central Authorizer," or central clearinghouse for system authorizations maintained in the Roles Database, the central system of record for certain authorizations. The CA Oversight Committee comprises members of the CA/BLT, the Controller's Accounting Office, Information Systems, Financial Systems Services, and, recent additions, representatives of the Provost's Office and the School of Architecture. The CA Oversight Committee works with the CA to facilitate and support the ongoing use of the Roles database for maintaining authorizations, and to promote the further deployment of the Roles model for other business process system authorizations.

In May 2002, the Institute's cognizant audit agency, the Defense Contract Audit Agency (DCAA), invited the Institute auditor, the director of the Office of Sponsored Programs, and the controller, along with the Institute's independent public accountant PricewaterhouseCoopers (PwC), to present at a workshop for DCAA field staff on OMB Circular A-133. The presentation acknowledged the innovation and efficiency achieved through a coordinated audit approach, which MIT, along with the DCAA and PwC, has uniquely employed among the institutions for which the DCAA provides governance.

The Audit Division has taken several steps to echo the executive vice president's five broad themes for MIT administration within internal operations and audit practices. First among these is client orientation. Supporting our primary client, the MIT Auditing

Committee, while providing value-added audit services Institute-wide, has been a longstanding commitment of the Audit Division, one that is met through careful attention to the concerns and potential exposures that face the administrative and academic staff and the faculty, researchers, and senior Institute personnel they serve.

The second theme, collaboration, has been demonstrated particularly in our approach to construction audit; this responsibility can only be met through close involvement by the Audit team in the affairs of the Capital Projects group and project management. Our efforts in system implementation projects have also been carried out through strong collaboration, a mode which advances the needs of the auditor as well those of the overall project. Collaboration was vital to the success of the MIT Press physical inventory, where individuals representing three groups, the Controller's Accounting Office, the Press, and Audit all joined to accomplish the single goal of completing the task on schedule.

Sustainability is the third theme. Business solutions to audit findings must, as a first priority address the noted problem; to do this in a sustainable manner is the ultimate goal. Often management accountability (the fourth theme), reinforced through ongoing measurement, monitoring and reporting processes is a necessary ingredient in a sustainable solution. Improving and supporting management accountability is a goal for audit management in the upcoming year.

Professionalism is the fifth theme. Professionalism on the part of individuals in the Audit Division, as well as within the practices for the conduct of audit work, is an assumed standard for the internal audit function of an institution such as MIT. We recruit and retain people with professional certifications, support the ongoing maintenance of such certifications, and through communication and development nurture their understanding of their obligations as MIT internal auditors. A current theme at the division's semi-annual offsite meetings is defining the "Top Ten Best Practices for MIT's World Class Audit Function," and charting our course for implementing those practices. Through the dedication and professionalism of the current team, we believe this is an achievable standard of excellence.

Finally, as the upcoming year progresses, the audit management team continues to explore and compare internal administrative practices for audit plan development, audit methodology and uses of technology to "best practice" standards, and to consider opportunities to better leverage existing resources while meeting the Institute's goals for the division.

Deborah L. Fisher
Institute Auditor

Financial Systems Services

Financial Systems Services (FSS) coordinates the development, delivery, and maintenance of the SAP business application environment on our campus. The FSS scope is growing beyond its roots in financial systems support to include both Human Resources and some Environmental Health and Safety requirements. The themes of client orientation, collaboration, sustainability, accountability, and professionalism guide us through our work and are reflected in the synopsis of our work that follows.

The Human Resources-Payroll Project successfully completed phase one of its three phases. This first phase included the conversion to SAP Benefits for administering medical, dental, life insurance, and flexible spending plan enrollments for approximately 11,000 employees at both Lincoln Lab and campus. The phase was completed with the conclusion of benefits open enrollment in November and December. In addition 14 business process teams completed their analysis and redesigns. Each team presented their work to project sponsors, business sponsors, and a design review team before considering their task complete. The Design Review team is a project-created group that is made up of persons both from the departments, labs, and centers (DLCs) and from central administrative units. Phase two of the project is currently underway and will result in employment transactions, compensation activity, and organizational assignments to be performed in the SAP HR system.

Lincoln Laboratory has chosen SAP for its next generation of administrative computing systems. The lab joined with campus to implement the initial phase of the Institute-wide SAP HR-Payroll project, benefits open enrollment, during the summer and fall of 2001, and will implement additional HR-Payroll phases in the future. For its own use, Lincoln Lab will also introduce SAP functionality for Purchasing, Inventory, Property, and Accounting in early 2003. A web-enabled data warehouse will provide administrative reporting for all these business areas. Financial Systems Services, the campus SAP support organization, is supporting Lincoln in these efforts.

A new tool has been developed to effectively help the Administrative Systems and Policies Coordinating Council (ASPCC) anticipate the impact and subsequently monitor and "meter" the introduction and implementation of new technologies, new functionality, and significant business and administrative process changes to the Institute's DLCs.

The document contains information related to many of the activities and initiatives that will likely affect the Institute's administrative areas. The foundation for this tool is the administrative calendar, as developed by the Administrative Advisory Council II. To show the overall impact on DLC workload, the projected schedules for implementation of

information technology and changes in business processes are presented with the administrative calendar.

The Graduate Aid Simplification team, co-led by a member of the FSS Community Support team, is a business process redesign team of the HR-Payroll Project charged with recommending a clear and consistent method for making graduate student appointments, both for the short term and for the long term, where the graduate student appointment process is integrated with SAP HR-Payroll. This team is looking at the entire process from admissions through graduation, and it is considering all of the many departments that interact with graduate students.

The Graduate Aid Simplification team identified three key areas that need work: ownership of the overall graduate aid process; training and education in business policy and best practice, as well as in technical systems needed by all administrators involved in the graduate aid process; tuition for graduate research assistants needs to be taken out of the Payroll system.

Members of the FSS Community Support Team (CST) are working with staff from the Information Systems's Web Communication Services to develop a web site to facilitate administrative work at MIT. This effort responds to a client need for a consolidated point of access to information and resources. The web site will also incorporate the administrative calendar, which was initially created by FSS CST staff working with the Administrative Advisory Council II.

The FSS Buy Pay team continues to provide production and development support for the purchasing, receiving, inventory, and invoicing processes including transactional and master data information. In FY2002, we deployed some newly developed key functionality to our customers: journal voucher and verification of credit card purchases to the general community via SAP's web architecture. For the majority of the fiscal year, the Buy Pay team also was heavily involved in two of the Institute's major initiatives: Environmental Health and Safety and Lincoln Laboratory's SAP implementation.

FSS continued to work with the Technology Licensing Office (TLO) project, which began preliminary investigation in late October 2000. The objective of the project is to implement SAP functionality to support the management of intellectual property by providing the solutions for TLO functions related to accounts payable, accounts receivable, intellectual properties, and license agreements.

The Real Estate Foundation, Inc., a charitable foundation established in October 1997 and housed in the Treasurer's Office, is the newest subsidiary to be represented in SAP by going live on July 1, 2002. The foundation accepts donated real property on MIT's behalf, and transfers the proceeds from the sale of the property to the Institute. Representatives from FSS and the Treasurer's Office, with support from the Controller's Accounting Office, identified the requirements for generating a separate profit/loss statement and balance sheet for the Foundation directly from SAP, while permitting the subsidiary to be included in an Institute-level summation in the annual Treasurer's Report. This implementation extended MIT's use of the SAP Real Estate module to allow the foundation to record and report on donated real property.

Phase two of the Technology Review project involved the analysis, configuration, implementation, and rollout of SAP's Procurement, Accounts Payable, and Travel modules. This phase required tight collaboration and coordination with the Controller's Accounting Office, Technology Review, and Financial Systems Services. Sponsors, stakeholders, and business process owners were heavily engaged in this phase, which was completed on time and on budget, to the satisfaction of all involved.

A cornerstone of FSS that ensures the sustainability of our SAP environment is the quality assurance (QA) area. This QA function continues to strengthen both internally and to educate the broader community as to the importance of quality standards. This past spring, we performed risk assessment interviews with the stakeholders for each business area utilizing SAP.

During the year, FSS participated in two MIT pilots. The first of these, which also involved Information Systems, was a program review and entailed a process by which central administrative areas are periodically reviewed. The concept is an adaptation of MIT's Visiting Committee process. The particular approach employed was modeled on Northwestern University's program review process.

On its own, FSS piloted the use of the Excellence in Higher Education framework as a mechanism for conducting the self-assessment called for under the Program Review. Through that self-assessment we identified a number of "Areas for Improvement" and selected six as the most important. They were: strategic planning, stakeholder input, project management, performance management, workplace feedback, and communications. At year-end, efforts were underway in FSS to address all of these areas. We expect to complete each of these efforts early in academic year 2002–2003.

Charles A. Shaw
Director

Office of Budget and Financial Planning

The Office of Budget and Financial Planning (OBFP) is a professional service organization within the Institute's financial administration. Its mission is to support two client groups, the departments, labs, and centers on one hand, and senior management on the other, as they pursue the most efficient allocation of financial assets consistent with

the Institute's goal of continued excellence in education and research. The office is responsible for:

- Providing the departments, labs, and centers (DLCs) with the expertise and tools necessary to develop and maintain budgets that meet the needs of the individual while providing accurate base data to the Institute's financial plan
- Supporting senior management by monitoring the Institute's financial position and providing accurate and timely financial analysis, projections and recommendations as part of the process of developing the Institute's strategic financial plan
- Managing MIT's financial information asset through the development of innovative budgeting and financial modeling tools

Administrative Themes Initiative

In the course of fiscal year 2002, the OBFP continued to focus its activities within the framework of the five key themes of client orientation, collaboration, sustainability, accountability, and professionalism outlined by the executive vice president in the 1999-2000 report. Within each of the above areas, special emphasis was placed on those activities that helped streamline the existing financial processes and align budget reporting with Generally Accepted Accounting Principles (GAAP) as applied in the preparation of the Institute's externally audited financial statements.

The office also made good progress in integrating its operation within the larger framework of the Institute's financial administration. The most significant outcome of this focus was the joint development of a new quarterly reporting and closing process with the Controller's Accounting Office (CAO).

The following eight activities significantly assisted in making progress in this area:

- The development of a new Statement of Financial Operations, which comports with GAAP, in the Budget Book
- The joint development with CAO of a new quarterly reporting and closing process
- The implementation of new internal and external revenue GL accounts in the 2003 budget process for the administrative units
- The introduction of significantly streamlined procedures for the tracking and closing of buildings and space changes. This was a joint project between OBFP, CAO and its properties team, and Facilities
- The reorganization of capital projects and space changes into separate and exclusive Profit Centers within SAP. This was a joint project between OBFP, Facilities, and the Data Warehouse team.
- The implementation of new carry-forward guidelines for the administrative areas, to fulfill the executive vice president's policy of tracking the use of moneys carried forward separately from the new fiscal year budget.

As a result of these initiatives, the Institute's budgeting process is realigned to better support the use of budgets as tools to improve cost effectiveness, as outlined during last year's budget seminars. Each of the above projects is covered below in more detail as they appear, along with other significant Budget Office activities, within the framework of the five key themes.

Client Orientation

During 2002 seven members of the OBFP staff where nominated by clients or colleagues of other administrative departments, to receive a prize within the Institute's Rewards and Recognition program. Our Infinite Mile winners were nominated by the School of Engineering and CAO, and Appreciation Award winners where nominated by Information Systems (IS), OSP and CAO. This is a welcome testimonial to the efforts of the Office of Budget and Financial Planning to work with their clients as facilitators in financial matters.

The Client Partnership Program, which OBFP instituted in 2001, was significantly expanded this year. This program was inspired by the remarks of two deans about the importance of face recognition at the client's site during a recent EVP management retreat. The key points of this program are:

- Proactive participation by budget officers' in administrative officers' meetings within their assigned departments, labs and centers
- A concerted effort to tailor processes and systems to meet client needs
- Periodic strategic planning sessions with the assistant deans and their fiscal officers

This program has resulted in more efficient procedures and information exchange tailored to the specific needs of our clients. A minor but significant metric is that a budget officer typically spends an average of 20 to 30 percent of his or her time at the client's site.

Collaboration

Several important collaborative projects were completed or got under way during the past year. The underlying theme for all of them is streamlining processes, improving the quality of data available to the Institute and enabling the DLCs to use their budgets as tools to better manage their financial resources. Following is a list of the key projects.

During FY2002, the Budget Office and CAO began a joint project to develop a standard quarterly GAAP reporting format. This format was then adopted for quarterly budget and financial reports, as well as for the GAAP exhibits in the FY2003 Budget Book. The result is an earlier and deeper understanding of the Institute's financial position and unit results, a more standardized closing process, and an alignment of financial information for senior management, the auditing committee, and the executive committee.

A joint OBFP and OSP project resulted in significant improvements to the quality of monthly research volume reports, in order to better fulfill the client's needs (the provost, in this case).

A joint Facilities, OBFP, and IS (Data Warehouse) project team began working in FY2002 to enable more efficient reporting and tracking of capital projects by grouping these projects within exclusive profit centers. The work of this group is expected to be complete in FY2003.

The Buildings and Space Changes team, made up of members from OBFP, CAO, Facilities, and Property Management, collaborates on a regular basis to ensure that MIT's increasing fixed assets values are accurate and auditable. With the amount of construction currently underway at the Institute, this vital and complex function is even more of a challenge than usual.

Medical department budgeting and financial reporting according to lines of business is a joint project with the Medical Department, CAO, and the Data Warehouse team. This is an ongoing effort to enable reporting of Medical Department revenue and expenses along both business lines and specialties.

Other noteworthy collaborative activities include:

- Working with IS to analyze the financial impact of the telephone and network rate change on the Institute
- Assisting in the redesign of the Human Resources system: two OBFP staff are active members of the Design Review and Management Organization teams
- Execute MIT's most recent tax-exempt bond issue in collaboration with the Treasurer's Office, the Controller's Accounting Office, and the Department of Facilities
- Continued reconciliation of construction gifts reported by the campaign vs. construction gifts and funds available in the MIT capital plan. This activity involves close collaboration with the Office of Resource Development, the recording secretary, and the Department of Facilities, and results in consistent projections for MIT senior management.
- Periodic forecasts of construction projects cash flows and debt requirements under changing gift and project cost assumptions for use in the ten-year financial plan and in the Building Committee decision-making process. This activity involves collaboration with the Department of Facilities, the Office of Resource Development and the Treasurer's Office, as well as the recording secretary.

Sustainability

During the past fiscal year the Office of Budget and Financial Planning has made significant progress in defining the standard format of key financial reports and in modifying its systems infrastructure to support and automate the reports' production.

The new financial statement, as published in the FY2003 Budget Book, is the culmination of a number of years of collaborative effort. This view, which was inspired by the leadership of the executive vice president, has been developed into a standard format that will be used for all future reporting. Perhaps more importantly, our systems infrastructure is being modified to produce this view automatically, rather than relying on database queries and manual assembly and editing, as in the prototype. This will result in a significant reduction of the time needed to produce it and the reduction of errors.

The ten-year financial planning model, developed within the OBFP, has become a key tool used in the development of the Institute's financial plan. To ensure its ability to sustain the plan and to improve and expand its functionality during this last year, we have reworked the existing model from an Excel-based architecture to a modular database-supported structure. The new structure is sustainable, expandable, and enables greater internal integrity of the system, better tracking of assumptions, and quicker turnaround of projections.

In response to a request from the Financial Issues discussion group, a sub-group of the executive committee, we developed a standardized "dashboard" reporting of the status of the Institute's key financial metrics. This will be used by both the executive committee and senior management as a monitoring tool. Here too, the systems have been modified to automate the production and updating of the dashboard on a monthly basis.

To ensure sustainability, our office relies heavily on information technology and systems. During the past year we have added an additional degree of sustainability to our IT infrastructure by adding a backup domain controller, doubling our office server capability, tuning the Oracle database, and upgrading our color print speed capabilities.

Accountability

Accountability is a key theme for us. Our office is composed of a small group of highly skilled professionals who are personally committed to fulfilling their obligations and responsibilities. The group works as a team. Each person's

contribution is often dependent on the work of others in the office and is critical to the team's collective added value. Just as we are committed to individual accountability, our office is also committed to improving the accountability of the budgeting process. This past year we were involved in three such activities:

- The implementation of the new carry-forward guidelines for administrative areas has added a measure of accountability to the Institute's budgeting and reporting process. For the first time, the administrative departments' carry forwards were segregated from their regular fiscal year budget. These dollars were placed into separate accounts and those accounts were then monitored to insure that the monies were used for the stated purposes.
- Last fiscal year our office was involved in a joint project to establish a set of new internal and external revenue GL accounts. This fiscal year saw the extensive use of these accounts by the administrative units in order to forecast sources of revenue with the same accuracy as spending forecasts.
- Medical Department financial reporting according to business lines (mentioned above under collaborative activities)

Professionalism

Professionalism tempered with courtesy is the cornerstone on which quality service to our clients is based. We constantly seek to maintain and improve our level of expertise, both in areas relevant to the mission of our office and in terms of individual knowledge and qualifications. During the past year OBFP staff have been involved in the following activities:

- Attending the Oracle Openworld Conference
- Participating at a two-day SAP Federal and Education Budgeting focus group. The purpose of this meeting was to distill the requirements of various federal agencies and institutions of higher education for a future SAP Budgeting Module.
- Participating in the Work Flow Project
- Attending the annual Financial Officers Group meeting, hosted this year by Princeton University

In addition, we actively encourage individual staff members to enroll in credit courses for professional development. Two of our staff members are currently working towards MBAs from Suffolk University. One staff member has attained a certificate in Oracle database administration from Northeastern University. One staff member has just completed the Massachusetts CPA exam and is awaiting results. In addition, most of the staff has participated in individual development classes primarily in the areas of technology use and finance.

In the coming year, we will continue our efforts to keep all five key administrative themes operational. Our office has set its own goals on working smarter by developing sustainable, simple processes that can support our role in encouraging greater effectiveness in the allocation of financial resources within the Institute's budget process.

Stefano Falconi
Director of Finance

Office of the Controller

The Office of the Controller comprises the following groups:

- Controller's Accounting Office (CAO) provides general accounting and payroll services to the Institute including accounts payable, accounts receivable, travel, sponsored research accounting, general ledger, financial reporting, employee and retiree payroll, and retirement plans accounting.
- Procurement Office assists the MIT community in the procurement of goods and services—providing advice and services that ensure favorable prices, protective terms and conditions, and compliance with MIT and federal policies and procedures.
- Property Office is responsible for the accounting and asset management of over 160,000 items of equipment that are both MIT- and sponsor-owned, and tracking all capital costs associated with buildings. (In FY2002, the Property Offices on campus and at MIT's Lincoln Laboratory were combined under one director, providing improved opportunities for streamlining and coordinating similar operations.)
- Lincoln Fiscal Office provides accounting, payroll, cashier, and cash management services to MIT's Lincoln Laboratory.
- Insurance Office purchases casualty, property, and construction insurance for the Institute and administers claims.

Fiscal year 2002 was a busy and fulfilling year for the Office of the Controller. We were able to support the Institute's needs and increase our level of service. The year's excellent results are due to all the Controller's Office employees who worked together to accomplish our goals. The follow sections describe some of the year's highlights.

Systems

The pace of work on two major extensions to the SAP system—SAP Human Resources/Payroll and the MIT Lincoln Laboratory Enterprise Resource Planning (ERP)/SAP project—increased substantially in FY2002. At the same time improvements continued to be made to the core SAP financial system, while only necessary system changes were made on a priority basis to Lincoln

Laboratory's legacy systems, as emphasis has shifted to SAP development. In addition, work continued on e-commerce technology on both the buy and sell sides to permit MIT departments, labs, centers, and affiliated groups the ability to accept payment for goods and services by credit card via the web, as well as improvements in Business to Business (B2B) functionality.

Some Controller's Office staff worked full time on SAP Human Resources/Payroll, and others participated in the Design Review Committee and various short-term project teams. The SAP Benefits module began to be used by Benefits Office staff in July 2001, and was extended in November to support the annual benefits open enrollment. In the payroll area, management reports containing detailed analyses of pension payroll requirements were completed.

MIT's Lincoln Laboratory has embarked on a significant effort over the next several years to partner with the campus in the implementation of SAP as the laboratory's ERP solution, starting with accounting and finance and property functions. In FY2002, accounting and technical staff from the Lincoln Fiscal Office continued to participate in the Lincoln Laboratory ERP/SAP development effort.

The Controller's Office collaborated extensively with other central units and department, lab, and center staff in two significant updates to the SAP financial accounting system during FY2002. In November 2001, a series of enhancements were added to the ability to use the web for SAP functions, including web journal documents, web verification of credit card charges, and a web interface for the annual benefits open enrollment, and in April 2002, a series of SAP updates were made to keep the SAP system current and to support future functions in SAP, such as Human Resources. These updates, with specific enhancements too numerous to list, increased the overall utility of SAP to the MIT community as well as its sustainability for future growth. Using the multiple enterprise structure added last year, we completed the first year of operations with a separate SAP company code for Technology Review, and the infrastructure is in place to add the Real Estate Foundation and the MIT Retirement Plan (Defined Benefit) as separate company codes in fiscal year 2003. Also this year, the SAP asset module was expanded to include all costs associated with capital software.

In October 2001, an enhancement to SAP that permitted the MIT community to view images of vendor invoices posted by Accounts Payable in SAP was put into production, to an overwhelmingly positive response from the community. The new imaging technology has reduced the need to call Accounts Payable for an explanation of charges, and decreased the need to send paper backup via campus mail. In future, imaging will decrease the need for archiving and storing paper invoices.

Controller's Office staff continued their collaboration with Information Systems to develop a secure credit card server for MIT. The project is now being piloted for both web and back-office credit card processing. The program will provide secure credit card processing for the web without the processing fees charged by third party vendors. For back-office credit card processing, the program offers significant improvements in security surrounding the issuing of credits to credit cards.

Reporting

The new quarterly reporting process, a collaboration between the Controller's Office and the Office of Budget and Financial Management begun in FY2001, continued to be refined in FY2002, with measurable improvements in timeliness and accuracy each quarter. The goal was to show the quarterly operating results in a way that reflects both the way the Institute's general budgeted monies are managed and accounted for, and the way operations, including general, designated, and research funds, are reported in the Institute's published financial statements. The first quarterly 2002 report was favorably received by the auditing committee and senior management. The result is an earlier and deeper understanding of the Institute's financial position and results, a more standardized closing process, and an alignment of financial information for senior management, the auditing committee, and the Corporation. The table below shows improvements in the time required to close the fiscal year, before SAP implementation in 1995 and this year.

Year-End Closing Comparisons

	FY1995	FY2002
# of Closing Periods	5	2
# Days to see output from journal documents	3-4 business days	Immediate (without EB*) Next day (with EB)
Final closing date for departments	August 2	July 17
Final closing date	August 22	July 25

* EB is the calculation of overhead for Employee Benefits.

Also in the reporting area, the Controller's Office led an effort to consolidate and improve internal and external debt accounting for the Office of Budget and Financial Management, the Controller's Office, and the Treasurer's Office, and developed a financial statement format and financial statements for the internal and external review committees for Information Systems and Financial Systems Services.

This was the second year that the Report of Sponsored Research Activities for the Fiscal Year (Brown Book) was available on the web. This year the Research Expenditures by Sponsors schedule was made available for download in Excel spreadsheet format, a feature that was well received by users of the report.

Insurance

The biggest challenge faced by the Office of Insurance in FY2002 has been grappling with the dynamics of a hard insurance market, triggered by a host of factors, but most significantly, the losses caused by the terrorist acts of September 11, 2001. Multi-year policies, with renewals in FY2003 or beyond, have insulated the Institute from experiencing exorbitant increases across many lines of coverage, including general liability, excess, and directors and officers policies, fine arts and business travel accident insurance. Staggering increases in premiums have resulted upon the renewals of the Institute's umbrella, aviation, and blanket property policies. Fewer viable insurers willing to quote, offering lower limits of coverage, only upon submission of substantial underwriting information, has become the standard. These trends will continue in FY2003 as insurance companies cancel policies, reduce coverage, and increase premiums.

Collaboration and communication with many departments, on an ongoing basis, has been a key initiative in addressing concerns regarding insurance coverages, liability issues, and proactive risk management strategies. The Insurance Office will continue to take a proactive role in this process.

Audits

Controller's Office staff both on campus and at Lincoln Laboratory participated in the FY2001 A-133 government audit, which consists of two main parts: an audit of the basic financial statements and an audit of the entity's major federal award programs—research and financial aid. The audit concentrated on review and testing of internal controls. Controller's Office staff continued to support the Defense Contract Audit Agency's (DCAA) ongoing audits by providing information and reports. There has been an increased effort to provide separate audit information on classified projects, so in essence, each request made during DCAA's annual A-133 audit had two components to it and had to be acted on separately.

The Department of Labor concluded its review of MIT's basic retirement plan for period 1996 through 1999, with no exceptions identified. The property system was approved with no audit findings or recommendations, after a property system survey conducted by the Office of Naval Research. The Defense Contract Management Agency (DCMA) reviewed and approved the property control system at Lincoln Laboratory.

The following sections highlight selected new and existing efforts within the Controller's Office to implement the five themes established by the Executive Vice President's Office.

Client Orientation

Through its wide range of services, the Controller's Office serves virtually everyone at MIT—faculty, students, staff, and retirees. We listen to our clients daily through a variety of formal and informal mechanisms—face-to-face, telephone, issue-oriented electronic mail lists, and meetings. We disseminate information our clients need to know using vehicles such as the controller's message on the monthly financial statements, announcements to a financial administrators' electronic mail list, our web pages, periodic administrative officer meetings, presentations to individual departments, year end closing meetings, vendor fairs sponsored by Procurement and the Travel Office, and training sessions such as the VIPcard class.

We also assist departments, labs, and centers on business issues, processes, accounting practices, and financial reporting. This year we expanded our support for specific client projects, assisting with service center and product family reporting for Information Systems, revenue recognition reporting for the Center for Advanced Educational Services, payroll reporting from the Data Warehouse, Athletics financial processes, and development of a standard set of monthly financial statements encompassing all of the dean for student life's areas. In addition, with the Audit Division, we supported the MIT Press physical inventory and made recommendations to improve their inventory and consolidation accounting. We also worked with the Media Laboratory to develop better reporting for consortia, and partnered with them on business process and accounting issues.

Collaboration

As the central organization that processes and consolidates MIT's financial transactions, the Controller's Office collaborates with other units on a daily, ongoing basis as an essential part of our work. The Controller's Office participates in all financial-related project teams, which last year included numerous SAP teams, e-commerce sales, Environmental Health and Safety, daycare, the health and fitness center, Information Systems processes and standards, and Lincoln Laboratory property. We work with the Safety Office, Environmental Medical Services, Risk Management, the Audit Division, and Facilities to address loss control issues. A Building and Space Changes team with staff from Facilities, the Controller's Office, and the Office of Budget and Financial Planning collaborates on a regular basis to ensure that MIT's fixed assets are accurate and auditable. We selected e-commerce vendors in partnership with Information Systems and community representatives.

Other significant collaborative efforts in FY2002 include working with the Benefits Office to perform an administrative assessment of the basic retirement plan benefits and record keeping and with the Benefits Office and a third party administrator to provide retirees who have variable annuities with a one-time option to transfer to a fixed annuity. We also worked with the Office of Cost Analysis to conduct the annual indirect cost study for the equipment and building pools, which resulted in a recovery of over $25 million.

Sustainability

The systems work described previously enhances the sustainability of our business processes and systems. Below are several other examples of efforts last year that also contribute to sustainability.

Partnerships with preferred vendors for commodities and travel are part of our strategy for sustainable procurement, and have been successful in enabling MIT to use its aggregate buying power to obtain favorable prices. This year we added partner vendors for maintenance, repair, and operating supplies and bottled water (a joint partnership with Harvard). We renewed the contract with our office supplies partner, replaced our partner for computers and related equipment, selected a new office furniture distributor, and established a list of four recommended vendors for copiers and other office machines. To support the change in computer equipment partners, we worked with those vendors to develop an electronic catalog for our ECAT (MIT Electronic Catalog) system, so that members of the community would have the same convenience of web shopping and purchasing with the new vendors that they had with the old. The computer vendor switch was made in the spring, and has been well received by the community. Electronic catalogs for other new partner vendors are currently under development.

In the area of benefits, administration of the Flexible Spending Accounts benefits program was outsourced to a third party administrator commencing with the 2002 benefits plan year, and oversight responsibility was transferred to the Benefits Office. The transition went smoothly.

In Sponsored Accounting, which is responsible for the funding and financial reporting for all sponsored research contracts and grants, improvements to the SAP billing system have reduced time spent on monthly bills, permitting staff to spend more time on financial reporting. The results have been significant, with a reduction in the backlog of outstanding Industrial audits from over 1,900 to just under 1,000 within the last year.

Accountability

Responsibilities and roles are clearly defined in the Controller's Office areas. This information is published for the community on our web pages, beginning with the directory of CAO Offices on http://web.mit.edu/org/c/cao/www/offices.htm/, which includes the names of supervisors of operating units. A variety of operational measurements are compiled and reviewed by the different units, and summary operational dollar and transaction volume metrics are collected monthly. For example, the Controller's Office continues to monitor and log all issues sent to the accounting-issues@mit.edu electronic mail list and review purchasing transactions for compliance with MIT and federal policies. Also in the area of compliance, this year we worked with Dun and Bradstreet to improve our vendor database to more accurately report socioeconomic procurement data required by the government.

Representative Metrics

The following selection of metrics gives an idea of the volume of FY2002 transactions in various operational units in the Controller's Office.

During FY2002, the number of active cost objects in SAP grew 14 percent to 40,792 by year end, comprised of 5,403 cost centers, 29,053 internal orders, and 6,336 WBS elements. Approximately 35,000 financial transfers were done via SAP journal voucher, totaling almost individual 340,000 line items. Over 17,000 items of equipment were tagged by the campus and Lincoln Laboratory Property offices. This year, for the first time, the number of VIP procurement card transactions exceeded the combined number of procurement transactions by other methods—electronic and paper requisition.

In addition, data entry in Accounts Payable has been significantly reduced by the development of electronic invoice feeds from internal organizations such as Medical and the Libraries. This year, approximately 39,000 non-purchase order invoices were electronically entered into SAP, avoiding almost 300 days of data entry effort.

Professionalism

MIT is the leader in e-commerce technology in higher education, with its VIPcard, partner electronic catalogs, and merchant services programs.

This year representatives from the Procurement Office worked with the National Association of Educational

Volume of Payments During FY2002 (# in thousands)

	Non-PO Invoices		PO Invoices		VIP Credit Card		Travel Vouchers		Payroll Payments		Pension Payroll (excl. lump sums)	
	#	$M	#	$M	#	$M	#	$M	#	$M	#	$M
Campus	91	$253	199	$751	118	$23	29	$32	282	$529	66	$100
Lincoln	–	–	82	$142	–	–	7	$2	59	$176	–	–
Total	91	$253	281	$893	118	$23	36	$34	341	$705	66	$100

Buyers to host a national conference on electronic commerce, with MIT's ECAT electronic catalog a highlight of the event.

The Controller's Office staff makes significant contributions to industry groups such as the Boston Consortium, Masco, the National Association of College and University Business Officers, the Massachusetts Higher Education Consortium, the American Payroll Association, and the National Property Management Association.

In addition, the Lincoln Fiscal Office participated in a business services benchmarking analysis, comparing key indicators of Lincoln Laboratory with those of three peer organizations, two other Federally Funded Research and Development Centers (FFRDCs) and one University Affiliated Research Center (UARC). The objective of this annual effort is to understand the factors that influence the way a business function is performed and contribute to the practices, complexity, and cost of the function.

In the area of professional development, Controller's Office staff participated in this year's pilot of the Leader to Leader development program. We also completed pilot testing of a new course, Fundamentals of Financial Management, developed in collaboration with Financial Systems Services and three fiscal officers from MIT research labs and academic departments. This course for fiscal officers in departments, laboratories, and centers is now offered monthly.

James L. Morgan
Controller

More information about the Office of the Controller can be found at these locations on the web: http://web.mit.edu/org/c/cao/www/, http://web.mit.edu/org/p/purchasing/, http://web.mit.edu/org/p/property/www/, and http://web.mit.edu/ila/.

Office of Sponsored Programs

The Office of Sponsored Programs' mission is to conduct the centrally organized administrative, business, and financial functions related to grant and contract administration and to assist faculty, principal investigators, and their administrators in the identification of resources for and the management of individual sponsored projects consistent both with MIT's academic and research policies and with the stewardship requirements of and obligations to external sponsors.

Research Volume

For fiscal year 2002 the total volume of sponsored research performed on campus was $454,495,000. This increase of $47,100 million represents an increase of 11.6 percent in total volume compared with the FY2001 volume of $407,423,000. The breakdown by sponsor is shown in the table on the following page.

Compliance Issues

The most significant development over the past year has been the increased focus of federal agencies (particularly NIH) on the issue of compliance. New requirements have been implemented designed to protect humans as subjects, particularly requirements concerning the disclosure of certain financial information in human subjects Informed Consent forms. The government now also requires federal wide assurance (FWA) with respect to human subjects and is moving toward more detailed financial disclosures for both individual and institutional conflicts. Issuance of Responsible Conduct of Research guidelines, delayed after the events of September 2001, is anticipated this coming fiscal year.

By September 2001 in a cooperative effort between the Committee on the Use of Humans as Experimental Subjects committee chair, OSP, and personnel from Information Systems, MIT deployed a secure web-based

Campus Research Volume by Sponsor—1993–2002 (in thousands of dollars)

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
FEDERAL										
DHHS	64,882	60,192	61,066	58,211	57,215	58,938	58,246	65,905	69,539	74,806
DOE	57,325	63,180	67,114	69,588	70,753	70,281	63,138	57,000	57,780	59,658
DOD	66,769	61,601	55,866	59,997	67,858	64,776	65,718	65,686	60,971	60,117
NSF	38,008	39,574	38,564	35,837	36,347	36,264	35,352	35,669	37,520	44,878
NASA	32,324	37,449	41,291	39,190	36,947	30,227	27,301	22,734	18,592	25,119
Other	8,899	8,722	9,641	8,721	7,232	9,115	7,409	6,753	6,777	11,562
Subtotal	268,207	270,718	273,542	271,544	276,352	269,601	257,164	253,747	251,179	276,140
NON-FEDERAL										
Industry	62,068	59,117	56,120	67,164	75,194	74,062	74,325	73,609	92,036	106,572
Nonprofit	25,593	23,666	26,430	25,926	28,952	36,197	42,214	50,970	55,588	63,638
Other	5,487	6,173	5,597	5,649	7,382	6,495	2,344	5,662	8,620	8,145
Subtotal	93,148	88,956	88,147	98,739	111,528	116,754	118,883	130,241	156,244	178,355
TOTAL	**361,355**	**359,674**	**361,689**	**370,283**	**387,880**	**386,355**	**376,047**	**383,988**	**407,423**	**454,495**

training program for the use of humans as subjects that is replacing the paper-based training course that had previously been used.

Costing Issues

The Institute addressed a variety of costing issues during the past fiscal year, ranging from cost sharing and effort reporting policies and issues to negotiation of Facilities and Administrative (F&A) rates for future years. Items of particular interest are described below.

Cost Sharing and Effort Reporting

MIT has continued efforts toward streamlining its collection and reporting of cost sharing and effort reporting data. Some advantage accrued to all universities as a result of the clarification memo issued in January 2001 by the Office of Management and Budget. Since in many ways the MIT policies and procedures preceded the final policy changes by the government but anticipated the federal changes, MIT did not need to make major changes to its procedures to implement the regulations. However, through an FDP task force co-chaired by Julie Norris, Pat Fitzgerald, and Charles Paoletti (from ONR, Office of Naval Research), we are in the process of identifying other administrative areas where changes in the regulations would provide for streamlining and the elimination of non-value added activities.

Negotiation of Facilities and Administrative (F&A) and Employee Benefit (EB) Rates

MIT successfully completed negotiations with our cognizant agencies, DCAA and ONR, to establish F&A rates on a fixed with carryforward basis for FY2003 at 63.0 percent modified total direct cost. Employee benefit rates were negotiated for FY2002 at the same rates as for FY2001.

Other Costing Activities

The audit conducted annually as required by OMB Circular A-133 was successfully completed in March 2002 with an unqualified opinion, no identified material weaknesses, and a determination as a low-risk entity. In addition, OSP continues to work with the Controller's Accounting Office and the Facilities Department to identify, review, and compile costs for the construction of the Stata complex in accordance with the recent changes in OMB Circular A-21.

Administrative Theme/Internal OSP Initiatives

Client Orientation

OSP has continued its training program, which it offers each semester to the Institute community. This program covers a range of general federal topics (policies and procedures, applicable circulars, F&A and EB costs) as well as a cradle-to-grave summary of how to manage a research award.

We have added additional basic guidance on proposal preparation and review as well as post-award sponsored program administration to the OSP web site. In addition, we have begun regular meetings with clients to supplement the sporadic visits and presentations made in the past. Implementation of the web-based human subjects training course with its automated recording in the Warehouse of persons who have successfully completed the training has expedited the processing of NIH research proposals.

We are beginning to initiate a secure web-based financial conflict of interest reporting system. In another area, the Cost Analysis Office has been working with the appropriate units to review the allocation account process and set annual allocation rates for each unit subject to review by ONR.

Collaboration

Many of the training courses are being taught in collaboration with personnel from academic units. In other areas, OSP personnel have worked with academic units to use SAP in new ways to track and record research activities.

In this past year, numerous staff members have continued their roles on the Provost Office's team for development and implementation of improvements to cost sharing management. In support of these activities, we have held training classes and added additional guidance and training materials to the OSP web site.

Personnel from academic units have served as reviewers and collaborators as the MIT electronic proposal initiative has reached roll-out stage. During FY2002 OSP has held a series of sessions to show academic administrators how the COEUS screens can be utilized for simple but sophisticated reporting. These sessions (originally scheduled to be held three times) have been offered more than a dozen times so far this year.

Administratively, OSP has begun a collaborative activity with the Office of Budget and Financial Planning to develop more detailed quarterly research volume analysis reporting.

Sustainability

One key element for MIT is the growth in volume of its research endeavors. The metrics above show how the research enterprise has grown this past year, and its gradual growth over the past decade. OSP has developed, in conjunction with certain federal agencies, mechanisms for electronic receipt of awards (called TS 840s) and streamlined loading of the terms and conditions into COEUS. Along with this growth has come major financial and administrative compliance requirements and, primarily through the efforts of cost analysis, MIT has continued to integrate these requirements without disallowed costs or questioned systems.

Accountability

OSP is continuing participation in designing administrative processes that apply the MIT control environment, which sponsors and auditors expect, to new relationships and activities that require unique business approaches. For example, the move of the Research Subawards Office to OSP has been a step toward clarifying roles and responsibilities. Academic units no longer need to work both with OSP and with Procurement in the development and issuance of research subawards. The successful completion of audit reviews, F&A negotiations, and the establishment of rates underscores this.

Professionalism

OSP is a national leader in electronic research administration. We were the first institution to receive electronic awards in a standardized format from ONR, and we will be the first to be able to submit NSF FastLane proposals in an EDI format (coming in fall 2002).

Participation at a senior level in policy initiatives of the federal government, authoring books and book chapters, serving on national panels, and on the Council on Governmental Relations, testify to the professionalism of the staff and their involvement in the important research administration issues being addressed across the country.

OSP representatives continue to accept requests for meetings and presentations on our processes and tools. As one example, OSP is actively participating with the Boston Consortium in developing programs to cooperatively meet training needs throughout the Boston area.

Julie Norris
Director

More information about the Office of Sponsored Programs can be found on the web at http://web.mit.edu/osp/www

Operations

Audio Visual Services

Audio Visual Services' central mission is to provide presentation technology support for all types of Institute activities. The fulfillment of this goal brings the department to the heart of the Institute's educational endeavors, providing daily service to faculty, students, and staff in classrooms and lecture halls. Through the use of audio, video, and computer display and amplification technologies, department staff provided service for classes, conferences, seminars, and cultural programs, totaling over 12,700 events during 2001-2002. Total revenue for the year was more than $1.6 million. Major accomplishments of the past year are presented below.

Customer Feedback Survey Development

In keeping with the department goal to improve service, a customer survey was developed during the fall semester. By accessing a database through a web interface, professors and other presenters in major lecture halls were polled on their experiences in using Audio Visual's services and installed equipment. A total of 65 people were surveyed and 14 responded, a 21.5 percent response rate. A five-position measurement scale was developed to measure satisfaction with several service-related areas including technician assistance, installed equipment performance and order placement procedures. The scale ranged from 0 – 4, poor to excellent. On questions related to technical assistance and customer service, respondents replied with an average score of 3.93 and 3.64, respectively. On questions related to installed equipment performance, respondents replied with an average score of 2.93. This survey will be further developed in the upcoming year to gauge customer feedback, improve service levels, and as a way to develop new services. The survey can be found online at http://avwebserver.mit.edu:591/room-survey.htm.

Service Agreements for Presentation Technology Systems

To provide the Institute community with reliable presentation technology installations in classrooms, the department developed a service agreement for systems maintenance with the Registrar's Office. More than 60 classrooms were scheduled for periodic maintenance on all systems, enabling users to have confidence that systems would be operational for classes and special events. Service agreements will continue to be a growing area of activity for the upcoming years as other departments install presentation systems that will need maintenance. The department will provide agreements for any department whose installations need attention.

Staff Changes

An additional administrative staff position was created to focus on event coordination. The new coordinator began in February 2002 and assisted the department's customers in planning and executing their events. This included many concerts, conferences, and all commencement-related programs. This position will continue to work with customers and other MIT service providers to improve levels of communication and event production in the future.

Presentation Technology Systems Consulting and Project Management

The department continued to actively participate in the development and installation of presentation technology systems for classrooms and meeting spaces. Some of these include the following:

- An upgrade to the sound systems in Room 34-101 was completed. A stereo program and speech audio system was designed and installed, improving the quality of audio playback for all events scheduled in the room.
- Various portions of presentation equipment systems were upgraded in Rooms 54-100, 4-370, 2-135, 4-231, and 6-120.
- Members of the department participated in the planning and development of the installation of the Technology Enhanced Active Learning (TEAL) classroom in 26-152. This room was designed around a new model used by the Physics Department in teaching freshman Physics. The room contains eight computer/video projectors and screens, a touchscreen control system, wireless microphones and video cameras.
- Classrooms 3-270 and 3-370 were renovated and contain state of the art presentation systems complete with touchscreen controls, computer/video projection, and media playback equipment.
- The Department of Materials Science and Engineering (DMSE) worked with MIT AV Services to design and install two spaces this year. The Nanotechnology Laboratory in Building 8 on the Infinite Corridor includes a 61" plasma screen, computer inputs around the lab, and media playback and sound systems showcasing the work done in the Lab. DMSE also installed a graduate student lounge including a computer/video projection system that students use while developing presentations and seminars.
- Beginning in the spring semester, the department acted as local consultant to MIT Facilities on projects to install a sound system in the renovated Next House dining room and a presentation system in the private dining room. Installation of these systems will be complete by late summer 2002.
- Several classroom projects are being installed during the summer in Buildings 1, 4, and 14 that will improve

the ability to display computer and video information to students.

- The Sloan School of Management is working with the department during the summer to upgrade six rooms with new computer/video projectors in time for fall 2002 classes.
- The sound system in the Gray House (President's House) was upgraded with the assistance of a local audio system integrator. This upgrade provides a system that is used for MIT Corporation meetings and greatly improves the audio amplification and recording capabilities in the room.
- Kresge Auditorium has received a new audio amplification system, improving the sound quality for conferences, concerts, and special events. This system was designed with the assistance of department members and a local audio system integrator.

Continuing Education

Two department technicians developed and taught a two-day workshop on live audio systems engineering and operation during IAP 2002. The workshop was attended by most technicians and was well received. Plans are being made to teach the workshop to a wider audience during IAP 2003.

Professional development in the department included attendance by five staff members at an audio system workshop offered in August 2001 by Shure, an audio equipment manufacturer. Four staff members attended Infocomm, the annual trade show and conference sponsored by the International Communications Industry Association (ICIA). All staff in the department are members of ICIA.

Several department members enrolled in courses offered at MIT's Professional Learning Center in customer service and various computer software systems. Future educational opportunities are planned for staff to maintain and increase skills.

Work began during the summer to upgrade the department's web site, allowing easier navigation and operation for users. The site will have links to the customer survey, order form, price list, policies, and links to other MIT service providers with whom we collaborate. The new website will be launched by the beginning of the fall semester.

Louis W. Graham, Jr.
Manager

Further information about Audio Visual Services can be found online at http://web.mit.edu/av/.

Copy Technology Centers

The goal of this organization is to provide the community with the highest quality copier and copier-related services. We continually strive to maintain a balance of providing new technology at reasonable costs. To achieve success, we pledge to institute creative programs of efficiency and quality controls, while maintaining sound business principles. We hold the customer at the center of our efforts and their satisfaction as our mission.

Accomplishments

The past year saw the beginning of many changes to the Sloan Copy Technology Center in East Campus. The center has long been a key distribution point of teaching materials to the Sloan School community. The department introduced a new supervisor and there were new efforts by the entire staff to revitalize not only the physical surroundings but also the mixture of services offered. Some of those changes included:

- Working closely with the Sloan School administrators to develop more efficient ways of distributing course materials. A more orderly and efficient method was unveiled that involved multiple locations and assigned times, resulting in students obtaining their material without delays. The communication between our center and the Sloan administrators allowed for creative solutions to the delight of all the parties involved.
- The center continued to refine the service of electronically scanning, cleaning, and storing course materials for distribution. The print on demand policy allows for faculty to conservatively estimate class needs and helps to eliminate unsold copies and the related costs to the departments at semester end. Hardware and software upgrades have led to a more streamlined process in this critical area of the Sloan teaching curriculum.
- A number of changes were made to the physical layout of the center. A concerted effort to eliminate unnecessary equipment and furnishings, redesigning the office and reconfiguring of the service areas have brought about a more open and inviting atmosphere to both customers and staff.
- Along with changes to the layout, efforts were made to dramatically upgrade the copier inventory in the center. Older analog and underutilized devices were eliminated and newer networked digital copier/printers were installed. In addition, the introduction of a new networked color copier/printer has been in response to the East Campus community. The center can now receive remote color files from customers for output to the new device. It also serves the color requirements of the walk-in customers.

The above efforts represent a department-wide response to the expressed needs of a segment of the MIT community. The positive results have positioned the Sloan Copy Technology Center not only for the present needs but also for future requirements that will surely come.

One of the largest areas of growth in the past year was the production of work submitted in electronic format. The past year saw a sharp rise in the number of customers taking advantage of our ability to receive customer files, proof their order, submit the document electronically to our networked printer/copiers, and deliver the finished product back to their office. This service has taken on a new and greater importance as technology allows for customers to design and create more elaborate print orders. A new manager of Media Services was appointed and a staff assigned to work specifically in this service area. Creativity and technology necessitated a dedicated group that has since been responsible for many complex and highly successful projects. Our Media Services group has been on the cutting edge in enhancing this service, introducing new software and hardware solutions to a growing number of Institute departments and individuals.

The CopyTech Express Center in W20 continues to be a unique and popular service solution to a varied group of customers. Whether a student needs to fax a document at 11 pm, the Conference Services department needs a number of posters printed on a Saturday, or a group of conference attendees in Kresge need to check their email, the versatile Express Center has responded. As a new and exciting focus emerges for the West Campus community, our center has recognized the need to remain flexible and responsive to all service requests.

The past year saw a revamping of our service to the Math and Chemistry departments. A long-time manned copy room serving those departments was reconfigured into a self-service copy room under our successful copier program. Newer, more efficient digital copiers were purchased and a simplified account system introduced to the area users. Along with those changes, a new three-times-a-day pick-up and delivery service, similar to a successful program initiated in the Physics department, was introduced to respond to the more complex copy requests of the departments. The combination of new copiers and a more responsive approach to specific needs has resulted in a very successful transition. These three departments serve as examples of how the Copy Technology Centers can seek out creative and tailored solutions to specific needs.

During the past year we laid the groundwork for developing a new electronic storefront for the centers. The ability to provide customers with a web-based option to browse, order, and purchase items online is a critical step forward. The wide array of companies that provide software programs, coupled with the intricate security needs of MIT require careful diligence in establishing this service. A number of vendor products have been researched and initial discussions with the necessary MIT departments have begun. The ability to offer this method of transacting business is a key to our department's future direction and goals.

As the current fiscal year ended, a number of equipment enhancements were made in the center in Building 11. Purchase of a new online booklet maker for our on-demand Heidelberg digital print system was completed. The device will allow for the growing number of workorders requiring booklet-making features to be run more cost effectively in-house rather than sending to a more expensive outside bindery. The completely automated device adds a highly requested module to our current system.

The process of reducing the number of outdated copier devices also began. Newer, smaller, digital units are being installed. These devices will meet the customer demands and significantly upgrade the copier fleet in the department.

The department made concerted efforts this past year to play a prominent role in the MIT community. Led by marketing manager June Milligan, the Copy Technology Centers have increased participation in many community events. Sponsorships to student groups, support staff initiatives, and departmental fundraisers have been successfully implemented. Many community-wide events have benefited from the donation of time and services by our department. This comprehensive program has grown to serve all aspects of the community and reinforces our mission to actively participate in the community.

The installation of a new chargeback billing system was a critical step in improving accountability to our internal customers. The new system, developed in partnership with Peggy Conant of Information Systems and our financial officer, Lee Finnegan, will greatly simplify our ability to accurately charge back for work performed. It also gives customers a more efficient and faster way of reconciling their costs. An improved information flow will be the most obvious feature that our community customers will notice.

The initial steps were taken to bring about a working partnership with a number of Institute teaching initiatives. Preliminary discussions have identified the Sloan School, MIT Libraries, and the new OpenCourseWare program as potential partners. Each of these seeks to enhance the distribution of teaching materials, as is the basic mission of our department. A natural progression to understand each of our roles and to avoid duplicate processes, is the desire of the early meetings. All have agreed that further involvement is not only necessary but of benefit to everyone.

Future Goals

The future goals of the department will continue to be shaped by technology and the change it brings. Our ability to react to those changes in a manner that is efficient and

of benefit to the community is crucial. We strive to be a flexible organization that can respond to any need and issue. We feel confident that we have made necessary changes and decisions that will accomplish our mission. The following are some of the goals we seek to achieve in the coming year:

- The completion of the electronic storefront project is a high priority. The need to offer an e-business solution is critical in competing with outside organizations. The benefits to customers will be realized in ease of researching information, acquiring pricing, confidence in file transfer methods, and secure options of payment. The project will allow the Copy Technology Centers to offer electronic services to the MIT community using cutting edge, web-based technology.
- The physical growth of the MIT campus necessitates our response. Our goal is to present comprehensive copier/print solutions to new buildings on campus (Stata Center, new graduate and undergraduate housing, etc.). This goal not only focuses on new construction, but also on existing areas that are being reinvigorated (West Campus). The centers will be proactive in bringing our solutions to any/all locations that will serve the best interest of the community.
- Another goal is to develop a new Media Solutions Center for the MIT community. This center would be a hands-on area to obtain information and see samples of the types of work ordered through a select group of outside partners. It would bring under one space diverse companies specializing in services we are not able to perform in-house. Customers would be able to ask questions, see samples, discuss options, and order online, all in an unhurried atmosphere. Tentative participating vendors include Charrettes ProGraphics, Birchcraft Studios, Business Cards Express, Proforma Promotions, to name a few. The goal is to present creative solutions to the diverse and growing needs of the entire community.
- The nature of our business often shows us a direction to follow. Our direction is being focused on working more closely with customers and departments in the complete process of creating, designing, transferring, producing and distributing documents. We recognize how different one person's needs are from the next, whether it is a department-wide solution or an individual one. We must react to those needs on a case-by-case basis. There must be flexibility not only in services offered but in pricing and implementation as well. This is a new challenge and one that we feel confident about as we proceed.

Kip Bruggeman, Institute Copier program manager, was co-recipient of this year's Infinite Mile service award for the Enterprise Services group. Don Choate was promoted to the position of media services manager. Donna Mulholland was promoted to the position of course content copyright administrator. Steven M. Dimond was presented the 2002 Gordon Y Billard award by the Institute, for service to the community.

Steven M. Dimond
Manager

More information about the Copy Technology Centers can be found on the web at http://web.mit.edu/ctc/www/.

Endicott House

Fiscal year 2002 was a challenging year resulting in a negative cash flow of $227,000. The September 11 tragedy, a steep economic downturn, and partial closing for renovations resulted in a $908,000 decrease in revenues. Although a dramatic change from the previous year, losses were minimized through $370,000 of expense reductions. FY2002 losses were reimbursed from Endicott House reserves.

MIT represented a 7 percent decline in bookings and a 14 percent decline in revenues. Major contributors to the reduction were two Sloan executive education program cancellations and limited availability during renovations. On the external side a more dramatic decline was experienced. Post September 11, bookings declined 32 percent and revenues declined 30 percent.

As noted in last year's report, in our effort to meet future conference and special event needs in the MIT Community the first phase of renovations and expansion were completed this past spring. The changes included a renovated kitchen area, serving line and buffet room that can accommodate display cooking; upgrades in life safety systems; and access improvements to the mansion that meet requirements of the Americans with Disabilities Act. Other enhancements include video conferencing, refurbished guest rooms, and new carpeting. The next phase of work at Endicott House will include a new 200-seat banquet facility, 63 more guest rooms (bringing the total to 100), a doubling of meeting-room space, and additional upgrades to the facility's infrastructure.

During renovations the department operated on a limited basis, focusing on day-meeting events and realizing $117,000 in revenues. With the facility partially closed, key staff were assigned roles in contacting previous users and potential users within the MIT community. This outreach combined with other marketing activities has generated a 34 percent increase in bookings YTD compared to FY2002. Sustained growth is anticipated in FY2003 with continued outreach and collaboration within the MIT community. Due to the slow economy, the external market provides great challenge as bookings YTD are down 32 percent from the previous year. Many long-term clients have reduced budgets for meetings and travel in the current economic climate. Marketing efforts under contract with Conference

Center Consulting Group continue to play an instrumental role in meeting the financial objectives.

Again this past year, the department maintained focus on meeting clients' goals and expectations. As in previous years, food quality, guest services, and staff commitment were ranked excellent. Employee training, motivation, and recognition programs played an important role. Additionally, during renovations all permanent staff remained employed as a measure of MIT's commitment to dedicated team members retaining trained staff.

Reinvestment in the physical plant and property for FY2001 totaled $233,000 in accordance with our 10-year capital plan. Projects included front desk relocation and renovations, driveway repairs, main house carpeting, video conferencing equipment, and master plan design work. Again this past year reclamation and enhancements of gardens around the main house and Brooks Center continues.

The primary goal in FY2003 is to rebuild business volume including growth in function business returning to positive cash flows, continuing to increase usage by the MIT community and expand training and development of managers and supervisors striving for excellence in guest service. Our continued achievements reflect the dedication and commitment of the Endicott House staff.

Michael Fitzgerald
General Manager

More information about the Endicott House can be found on web at http://web.mit.edu/endicott-house/.

Environmental Programs Office and Environment, Health And Safety Office

The Environmental Programs Office (EPO) is responsible for the strategic direction of environment, health and safety (EHS) services and systems at MIT, for overseeing the EHS Office, and for participating in and coordinating the development of institutional EHS leadership and policy, in collaboration with the Institute EHS Council, the Environmental Council, other Institute committees, and senior officers.

Together with colleagues from the academy and administration, EPO is leading the development of an MIT EHS Management System, which integrates compliance, environmental sustainability and health and safety initiatives, research and education. The management system will improve MIT's EHS performance, compliance, and accountability, while preserving the independence of research and teaching.

The EHS Office's primary responsibility is to provide EHS services to MIT's departments, laboratories, and centers (DLCs), as well as to support the Institute's accountability for EHS compliance and positive initiatives, to ensure the health and safety of the MIT community and the public and to protect the environment. The office is also deeply involved in development of MIT's EHS Management System.

MIT EHS Management System

To demonstrate MIT's long-held commitment to environmental stewardship, as well as to satisfy the requirements of a June, 2001 MIT, US Environmental Protection Agency (EPA) and US Justice Department Consent Decree, MIT continued efforts begun in fiscal years 2000 and 2001 to design and implement an MIT EHS Management System (EHS-MS), which will be a model for academic research. This management system will provide better institutional accountability for achieving and maintaining compliance with federal, state and local EHS regulations in MIT's laboratories, research centers, facilities and operations, while also retaining the independence of research and teaching. The EHS-MS will also create a more sustainable MIT by incorporating positive initiatives (reducing wastes and toxics, preventing pollution, conserving and reusing resources) into activities. The integration of compliance, positive initiatives, research and teaching defines MIT's EHS-MS, reflecting MIT's values and exceeding the consent decree and regulatory requirements.

An ad hoc EHS subcommittee of the Institute Council on EHS, co-chaired by the vice president for research and associate provost and the managing director for environmental programs and risk management, and senior counsel, and comprising senior faculty and administrators from across the Institute, is leading the development of the management system and approves each component as it is designed. Research and operations-oriented working committees of staff from DLCs work closely with the EHS-MS project team in the Environmental Programs Office to develop and vet ideas for the design of components of the management system including: EHS DLC and central organization; training; audit inspections; inventory; systems integration; web resources; the EHS manual; and the three supplemental environmental projects which are being undertaken in lieu of penalties under the consent decree. Approximately 85 members of the MIT community from a large cross section of DLCs are participating on these committees and project teams to ensure that the management system works well for MIT and is sustainable over the long term.

MIT EHS Policy

In December 2001, MIT's Academic Council adopted a comprehensive EHS policy to represent MIT's long-standing commitment to EHS stewardship in research, teaching and operations. The ad hoc EHS Subcommittee developed the policy, and the EHS Management System will implement it.

The policy provides:

> MIT is committed to excellence in environment, health and safety stewardship on our campus, in the larger community of which we are a part, and globally. This long-held commitment is demonstrated through our contributions to the environment, health and safety research and teaching, as well as through our institutional conduct.

MIT is committed to being at the forefront of large academic research institutions:

- in minimizing, as feasible, the adverse environment, health and safety impacts of our facilities, activities and operations to protect human health and the environment (which is one way we define sustainability)
- in achieving and maintaining compliance with federal, state and local environment, health and safety laws and good practices in all of our departments, laboratories, and research centers, facilities and operations;
- in achieving a high standard of institutional accountability for environment, health and safety stewardship, while maintaining the independence of research and teaching
- in providing educational opportunities to our students and other members of our community, to reinforce the values exemplified in this policy and influence their activities during and after their tenure at MIT
- in measuring and continuously improving our environment, health and safety performance

The policy and its 20 supporting principles are available online at http://web.mit.edu/environment/stewardship/policy.html.

Environment Web Site

An enhanced environment web site, http://web.mit.edu/environment, came online this year, providing information on everything environmental at MIT, including research, education and operations. The site, which is to be continuously updated, covers health and safety as well as the environment. This environmental hub for MIT features highlights on environmental research and educational programs, as well as EHS compliance checklists, regulatory resources (including waste pick-up services), commonly asked questions, and MIT's environmental sustainability and health and safety initiatives. Representatives of MIT's Environmental Council have been significantly involved in the site's development. The site reflects MIT's integrated and comprehensive approach to the environment which recognizes that our EHS operations must meet the high standards of our environmental research and teaching. It is intended to provide an easy view of the breadth and depth of MIT's environmental activities, opportunities, and commitment for prospective students, members of the MIT community and others outside of MIT. Additional navigation and design improvements are underway and content additions continue.

EHS Organization Structure In DLCs and Centrally

The ad hoc EHS subcommittee of senior faculty and administrators endorsed an EHS organization structure for MIT, as well as a menu of approved EHS organization options for DLCs. After a one-on-one meeting with representatives of the EPO, EHS Office and ad hoc EHS Subcommittee to elicit feedback and answer questions, each of the 40 highly or moderately regulated DLCs at MIT determined that at least one of the organization options would work for the DLC and the DLC committed to implement that option.

Common to all of the options are: the DLC head is ultimately responsible for implementing MIT's EHS Management System in his or her DLC and for the DLC's EHS performance; the DLC head is supported by an EHS coordinator who oversees DLC EHS performance and provides assistance concerning EHS organization, training, inspections and inventory, on a day-to-day basis, working closely with a lead contact and supporting team from the EHS Office; each principal investigator or supervisor of a laboratory or other facility is ultimately responsible for meeting EHS requirements in his or her research group or area, including by implementing relevant aspects of the management system; EHS representatives within each laboratory or facility assist the principal investigator or supervisor; each DLC will have an EHS committee, chaired by a senior faculty member and co-chaired by the EHS coordinator, and comprising other faculty, students and the EHS Office lead contact, to provide resources and oversight of DLC EHS performance; the MIT council on EHS and other EHS presidential committees will oversee MIT's EHS performance, including implementation of the EHS Management System, in close coordination with the managing director for environmental programs. The EHS Office has created lead contacts, backed by teams of experts, to provide resources and assistance to each DLC. The EPO and EHS Office worked with each DLC to do a resource and workload assessment, and the provost provided resources for additional DLC staff where needed. This assessment will be reviewed in six, nine and 12 months to determine whether assumptions were correct and ensure appropriate resource allocations.

MIT's organization for EHS services and oversight also continued to evolve. In October 2001, the single EHS Office consolidated its five programs—environmental management, industrial hygiene, radiation protection, biosafety and safety—into one location, newly renovated space on the fourth floor of N52. This has allowed for more collaboration among the five EHS disciplines and should

result in more efficient delivery of services in the years ahead as the EHS-MS is implemented.

As part of MIT's commitment to continuous improvement in the delivery of EHS services, a series of ten focus groups were held this past December and January to determine both client and staff satisfaction with EHS services and processes. The results of these discussions are integral to the evolving EHS Office organization design under the EHS Management System. In general, clients and staff viewed the strengths of the EHS Office as its proactive approach to partnering with DLCs, strong sense of the customer and sound technical expertise. The primary concern expressed was that the EHS Office needs to clarify and more regularly publicize its mission, roles and responsibilities, the resources it offers, and how to access the office services.

The EHS Management System development addresses these concerns as DLC EHS coordinators and EHS Office lead contacts form working partnerships and use tools such as the new website, EHS Management System manual and uniform training programs as they are implemented. A recently published supplement to the *Tech Talk* describes MIT's EHS policy, the EHS-MS roles and responsibilities, and EHS services and personnel. For additional copies, contact 2-EHSS or environment@mit.edu. The first issue of a quarterly EHS newsletter, *EHS News and Views* also went to press at the end of FY2002 and provides useful information for DLCs.

We will continue to emphasize our new service organization-one office, one call, one location, both physical and virtual. Our new web site (http://web.mit.edu/environment/) and single phone number (x2-EHSS) and one location will serve as a means to effectively handle all queries.

EHS-MS Training Materials

As part of the MIT EHS Management System and consent decree requirements, the ad hoc EHS subcommittee oversaw development of, and the working committees and project training team developed, uniform content for two web-based and live training modules: hazardous waste management and oil spill prevention. A collaborative approach was used to develop these two modules by conducting reviews with the working committees and other focus groups including graduate students. The modules will be available on an Institute-wide EHS training web site. The two web-based modules were submitted to EPA along with a training report that described the process used to develop the two modules. In addition, the foundation was established to develop the consent decree-required training needs assessment tool and uniform MIT EHS training program implementation plan, as well as additional EHS training modules.

Supplemental Environmental Projects

MIT continued efforts begun in fiscal year 2001 on three supplemental environmental projects (SEPs) undertaken in lieu of penalties under the consent decree. The SEPs are an environmental education and projects program with the Cambridge Public Schools, which is being managed by the MIT Laboratory for Energy and the Environment and its Program for Environmental Education and Research, with EPO and its EHS Office; a "Virtual Environmental Campus," a web-based environmental compliance and operations tool which graphically depicts good compliance and "green" practices on a typical campus; and an environmentally beneficial biofiltration stormwater management system at the Stata Center, presently under construction. The Virtual Environmental Campus was submitted to EPA in June 2002 for review, and the final version will be available online at http://www.C2E2.org later in FY2003. Efforts to complete the other two SEPs are proceeding as required in the consent decree.

Additional Service and Program Improvements

Construction Safety Program

Along with its ambitious capital building program, MIT is managing an unprecedented volume of renovations. To oversee the EHS aspects of these renovations and construction projects and act as an EHS liaison with the City of Cambridge Fire Department and Building Inspectional Services, a new position of campus construction safety officer was formed. The objective of this collaboration between the Department of Facilities' Design and Construction office and the EHS Office is to assist project managers anticipate EHS issues and work effectively with contractors and regulatory agencies to avoid project delays and adverse impacts.

Fire Safety Program

In collaboration with Residential Life, EHS professionals continued to educate residents about fire safety and proper emergency procedures. EHS professionals also worked with the Chemistry Department and Facilities to provide fire extinguisher instruction.

OSHA Confined Space

To satisfy an OSHA confined space rescue requirement, MIT entered into an agreement with the Cambridge Fire Department, designating the Fire Department as the rescue service for MIT in such situations. As part of the agreement, EHS Office experts worked closely with the Fire Department to ensure that the Fire Department department is familiar with the MIT campus and provided training to firefighters on rescue situations at MIT's campus.

Support of Research Experiment

The Bates Laboratory completed the final installment of the target/detector system called BLAST. This system

employs innovative instrumentation and technology to study the nuclear structure of polarized gas targets. The Bates Radiation Protection Program (RPP) collaborated with laboratory division leaders and user groups to design and evaluate facility shielding and access modes to meet safety and customer requirements. The Bates RPP also collaborated in a major upgrade of the facility emergency annunciator network. The annunciator system is interlocked with machine operation and provides a facility-wide announcement of emergency alarms. The design, installation and evaluation are conducted with a high level of professional care and ensure a sustainable system.

Enhanced Program Delivery

EHS continued its efforts to enhance delivery of services through the efficient use of technology and innovative techniques. The use of the web allows rapid communication and transfer of information for several programs including medical surveillance for animal handlers, submittal and review of DNA protocols as required by NIH, and filing of injury and illness reports required by OSHA. In addition, new databases were created to document and perform trend analysis for several programs including routine inspections of food preparation areas, validation of autoclaves' effectiveness, annual building inspections by the Institute's insurance carrier and select subsets of the environmental and personnel monitoring databases collected by many of the EHS programs. Hazardous waste pickup requests are now exclusively made on-line which improves access to the community and provides a record of performance that can be tracked.

Anthrax and Post September 11 Threats

After September 11, 2001 the biological attacks using anthrax through the mail caused widespread concern throughout the country. MIT was no exception. EHS, police and others responded to 26 suspicious envelope or package concerns. The Cambridge Fire Department HAZMAT unit responded when sources of suspicious material could not be confirmed. No packages or materials have tested positive for anthrax. The EHS Office has developed procedures for response and evaluation of suspicious packages. EHS is also evaluating field-testing materials for suspicious packages and envelopes.

EHS and other groups are working collaboratively to evaluate the events of September 11 and to suggest changes in our processes to improve communications, preparedness, and safety. EHS also works with MIT PD, local and regional civil agencies to stay aware of terrorism and crime threats and assists MIT in being prepared for such activity.

Positive EHS Initiatives—Green Campus Initiatives

Construction and Demolition Debris Recycling

The EPO and its EHS Office worked closely with the Department of Facilities Capital Projects Group and Design and Construction Services (DCS) to develop and implement a feasible Construction and Demolition (C&D) Debris Recycling Program. MIT conceived, hosted, and presented the new program at a C&D seminar in October. A standard specification was written for capital projects; its first use at the Media Lab demolition resulted in a 96 percent recycling rate for that project. Efforts to extend the program to all DCS projects are progressing, including a recent meeting with staff from EHS and DCS and several renovation contractors.

Pollution Prevention Activities

In addition to forming a pollution prevention component of the EHS Management System project for the coming year, several pollution prevention activities were initiated. A centralized silver recovery unit was installed for the recovery (rather than disposal as hazardous waste) of photochemical fixers in east campus. This program will be expanded campus wide in the coming year. Recyclable batteries are being purchased for EHS Office use in pagers, cell phones, and other battery powered devices. We also worked with the Medical Department in replacing mercury-containing syphgmomanometers with non-mercury containing devices.

Mercury Recycling Program

For calendar year 2001, the Institute shipped off-site approximately 900 pounds of elemental mercury for recycling. The mercury was collected from various laboratories and departments from across the campus as the result of a mercury reduction program and due diligence on the part of Institute researchers. MIT's EHS Office encourages laboratories and departments to exchange mercury thermometers and outdated manometers with non-mercury-containing alternatives.

Universal Waste/Battery Recycling

As part of an audit of the Universal Waste program (operated by Department of Facilities) EHS worked with Facilities to implement a campus-wide recycling program for rechargeable batteries.

Contracting

The EHS Office assisted the Department of Facilities in procuring new recycling vendors, saving a projected $80,000 over the previous vendor's price and maintaining a very broad-scope recycling program for MIT.

Recycling/Green Procurement/Food Waste Composting

The National Wildlife Federation recognized MIT's greening efforts. We have much more to do but the recognition was welcome. The Environmental Programs Task Force (EPTF) sponsored by EPO is improving recycling measurement and reporting processes, with vendors submitting data monthly to EHS. EHS assigned a full-time staff member dedicated to recycling issues and other positive initiatives.

Total tonnage recycled at MIT increased in calendar year 2001 by 53 percent over 2000 to 993 tons. However, waste also increased by over 2000 tons, creating an average recycling rate of 12.4 percent for 2001. (The rate achieved by the end of 2000 was 20.3 percent and the average rate in 2000 was 11 percent.) Recycled content products purchased through Office Depot and the Copy Technology Centers increased by 24 percent in 2001 over 2000. In 2001, 75 percent of all copy paper and 16 percent of all office supplies bought were made from recycled materials. Food waste composting increased from about four to nearly nine tons per month from 2000 to 2001, through expansion to Baker House and Next House. The gradual increase in the monthly tonnages being diverted resulted in an increase of from 50 total tons diverted in 2000 to nearly 92 total tons in 2001, an 84 percent increase. MIT's Green Building Guidelines were expanded to encompass previously articulated long-term environmental goals (see 2000 EPTF annual report) and performance standards, as well as life-cycle assessments to fully consider costs and benefits, and certain environmental costs that do not translate well into dollars (e.g., indoor air quality, nonrenewable resources, greenhouse gases).

Clean Charles

MIT continues to support EPA's program to achieve a swimmable, fishable Charles River by 2005. MIT's EPO and Government Relations Office sponsored a stormwater system design contest culminating with the awards ceremony held at the MIT Faculty Club in February. The contest was reported on the contest web site, in *Tech Talk*, and in *The Boston Globe*. We also provided support for a graduate student to assist with EPA contest preparations.

Select Biological Agents

The EHS Office sent out a questionnaire to update MIT's records on laboratories that have listed and non-exempt "select agents," as well as those that have exempt agents. The questionnaire went to the approximately 220 principal investigators working in any DLC where research with any type of biological materials was occurring, as well as to the approximately 20 heads, chairs, or directors of those DLCs and their administrative officers. The EHS Office then followed up with those few locations that have select agents that are listed and not exempted under the 1996 Anti-terrorism and Effective Death Penalty Act to notify individuals in those labs about the restrictions imposed by the post September 11, USA Patriot Act, so that they can comply.

Program Metrics for Environment, Health and Safety

The following data reflects the level of core service activities in the EHS Office in FY2002 without weighting for level of difficulty:

- Over 21,000 surveys were performed mostly in laboratories covering radiation use (required quarterly in over 700 labs), hazardous waste (2,800), laboratory ventilation hoods (2,300), use of biological agents (at least annually in 620 laboratories), decommissioning laboratories or equipment, and ergonomics.
- Over 200 investigations were conducted for indoor air quality, odor complaints, and chemical spills. Emergency response was made to 308 emergencies including 220 fire alarms.
- Over 3,000 laboratory analyses were performed for chemical (asbestos, metals, acids, solvents) and biological (blood lead, microbiological contaminants) materials in our nationally accredited industrial hygiene laboratory and biosafety laboratories. This level has been steady for the past several years.
- Over 3,000 individuals received training on a wide variety of topics including radiation use, work with biological agents, hazardous waste, ergonomics, emergency response, cutting and welding safety, hot works safety, fire safety, and compressed gas use.
- Approximately 540 people completed one or more of our three web-based training programs on chemical hygiene, hazardous waste or hazard communication.
- Reviews/audits were performed on 100 exposure control plans for work with bloodborne pathogens, 150 lasers, 40 analytical x-rays and 35 chemical hygiene plans. This is an increase of approximately 10 percent exposure control review plans from 2001.
- Over 750 people are enrolled in our medical surveillance program for users of chemical, biological or radioactive materials. This is approximately a 25 percent decrease from 2001 as EHS improved efficiency in determining which personnel belong in this program.
- EHS reviewed 14 major construction projects and 280 renovations.
- For the Residential Life Safety Program, two fire drills were held in each of 22 dormitories involving 1500 students and fire safety orientation was given to 100 participants.

- Every Institute building was inspected for life safety issues with our insurance carrier and separately with the City of Cambridge building inspector.
- Over 21,000 hazardous waste containers were collected from laboratories and managed—a 10 percent increase from 2001.
- Over 400 asbestos abatement projects were monitored and successfully completed and over 260 asbestos surveys were conducted.
- Respirator fit tests were performed on 250 respirator users, approximately 20 percent fewer than FY2001. This is due to improved efficiency in determining which personnel are subject to this program.
- Over 300 people were seen and treated for repetitive strain injuries. Site visits were made to 177 workstations.
- There are currently 150 authorizations for the use of radiation at MIT and 1,890 registered radiation workers. During the past year there were 10 new authorizations, 11 amendments to existing authorizations, and 48 renewal authorization applications processed.
- Approximately 2,000 deliveries of radioactive materials were received, monitored and delivered to laboratories. This is an increase of approximately 20 percent from FY2001.
- The campus radiation-monitoring program performed over 50,000 bimonthly surface, air and water samplings and analyses, and conducted 1,500 dosimetry samples on radiation workers.
- Surveys performed at the Nuclear Reactor included over 17,000 surface wipes, and almost 10,000 radiation surveys, over 1300 individual dosimeters were processed and 160 bioassays were performed.
- Surveys performed at the Bates Linear Accelerator included over 1900 wipe tests, and 2200 radiation surveys.
- There are 94 faculty principal investigators with registered research protocols that utilize either recombinant DNA technology or infectious agents. This encompasses an annual review of 169 research protocols; at least annual training and follow-up with 620 laboratories; and tracking and focused training during lab inspections with over 1200 research associates.
- Microbiological sampling performed for infection control and quality assurance included 64 for the MIT pool, 76 for the Medical Department, 240 for indoor air quality, 19 for animal handling for DCM and 13 for water analysis.
- The EHS Office advised the Department of Facilities and provided project management assistance on 17 contaminated sites and advised the Real Estate Office and provided project management assistance at 10 contaminated sites. We contributed technical and regulatory expertise to the Senior Counsel's office on several Superfund sites.

Regulatory Interactions

US Environmental Protection Agency

During FY2002, MIT met and/or exceeded all MIT-EPA-Justice Department consent decree requirements, including: a self-evaluation of existing environmental conditions; development of an MIT EHS Policy; development of a web-based Environmental Virtual Campus, a training tool for campus environmental compliance which is one of the Supplemental Environmental Projects in lieu of penalties, and is being tested and will be available to all colleges and universities online at http://www.C2E2.org later in FY2003; development of an EHS Organization in all DLCs across the Institute and centrally; and development of web-based training materials for hazardous waste management and spill prevention and control. Also see the section on Positive Initiatives undertaken with EPA above.

US Occupational Safety and Health Administration

There were two separate complaints filed with OSHA. One related to Building E32 and the other to Building NW30. Both were resolved with no citations issued.

Massachusetts Department of Public Health, Radiation Protection

The campus's broad scope radiation license was inspected in May 2001. Two inspectors spent 2.5 days reviewing the program. No violations were reported. A renewal application for MIT's broad scope license was prepared and submitted to the Massachusetts's DHP, Radiation Control Program. The application qualified our current license as timely renewed, thus there were no interruptions in use of licensed material by our research community. The renewal application reflected recent changes in our organization, location, and personnel. The special nuclear materials license was amended to reflect the needs of a nuclear engineering project that utilizes several radioactive materials. The Massachusetts DPH Radiation Control Program conducted a telephone inspection of the MIT and Whitehead Institute of Biomedical Research (WIBR) security programs in October 2002 as a result of the September 11 terrorist attacks and found security in order. The Massachusetts DPH Radiation Control Program conducted a surprise inspection of the licensed activities at the WIBR on April 28, 2001. The inspection resulted in no safety, security, or compliance violations. The WIBR management was pleased with the inspection results and

attributed success as a result of the strong RPP efforts at their facilities. The Nuclear Regulatory Commission (NRC) conducted an inspection of MIT's special nuclear material license (SNM-986) activities on January 27, 2002. The inspection resulted in no safety, security or compliance violations.

Massachusetts Water Resources Authority Interaction

MWRA inspectors visited the campus twice in the past year. No significant violations were noted.

Nuclear Regulatory Commission

The MIT Research Reactor was routinely scheduled for inspection by the Nuclear Regulatory Commission (NRC) two times during the last year. Additional inspections by the NRC were made for specific program areas. Each of the routine inspections was one week long. One of the routine inspections focused on the radiation protection program. During this inspection, no notices of violations (NOV) were reported and the one follow-up item (IFI) has been addressed and confirmed by the NRC. The other routine inspection focused on operations. This inspection resulted in no NOVs and two IFIs. One IFI related to reflecting the evolved EHS Office organization in the reactor's license, which has now been done. The other IFI was a reminder for the inspector to review with MIT new formal guidance by the NRC for all reactors of certain types, once that guidance is issued.

Cambridge Fire Department

Training for the Cambridge Fire Department Hazardous Materials Response Team was conducted for radiation safety, chemical and biological hazards, and air sampling techniques. Members of the EHS Office worked with the Fire Department on emergency planning procedures. MIT provided training to the Cambridge Fire Department in rescue techniques for confined spaces and high places.

Cambridge Local Emergency Planning Committee

Several members of the EHS Office participated as members of the Cambridge Local Emergency Planning Committee. A major disaster drill implemented by LEPC is assisting MIT in refining emergency preparedness planning.

Massachusetts Department of Environmental Protection

EHS submitted a comprehensive air emissions permit for the campus to the Massachusetts Department of Environmental Protection (DEP) in the past year. DEP is evaluating and analyzing the permit application presently. EHS reported to DEP regarding hazardous waste generation and pollution prevention activity, commuter trends and statistics for MIT, and provided DEP with many required reports regarding site work at the campus and regarding other MIT properties in Massachusetts. EHS also assists MIT Real Estate in their interactions with Mass DEP regarding property managed by Real Estate.

Massachusetts Department of Health Public Health

In January 2002, the Massachusetts Department of Public Health (DPH) notified MIT that it had inspected the Johnson Athletic Center ice skating rink and found some air monitoring violations. EPO and EHS staff worked with the skating rink staff to implement corrections and notified DPH of these actions. After receiving written confirmation of the corrections, DPH staff conducted a follow-up air testing inspection and then issued a new "certificate of approval" to the ice skating rink.

Jamie Lewis Keith
Managing Director for Environmental Programs and Risk Management
Senior Counsel

Facilities

Without question, this was the busiest and most challenging year for our department in decades. The level of activity involved in capital construction, space changes, and the needed response to 9/11 was daunting, but as a department we pulled together and minimized disruption on campus and kept the level of service remarkably high.

As the department responsible for the operations of buildings on campus, we have long maintained a program to deal with emergencies. However, following 9/11 we created a Facility Protection Team to review our current operating procedures in regard to the context of terrorism. Headed up by Joseph Gifun, assistant director for infrastructure renewal and special projects, the goal of the team was to make suggestions on ways to protect the assets of the Institute, its staff and students. Recommendations were brought to the various task forces established by President Vest to look at specific areas across the campus. Now that Executive Vice President John Curry has formed the Safety and Security Operations Team, the Facility Protection Team will bring issues related to the protection of MIT's facilities to it for discussion.

We are very proud of the integral role our repair and maintenance crew played in creating the Reflecting Wall that was constructed next to the chapel. This project was done in collaboration with the Department of Architecture shortly after the terrorist attacks.

Our Mail Services area increased the level of security around mail delivery following the anthrax scares. Our mail staff received additional training on safety and worked with the community to allay their fears around mail delivery. Martin O'Brien, the new manager of Mail Services, developed a training program addressing issues

of safe mail handling practices and methods of identifying possible hazardous mail pieces. He presented the program to managers from the Department of Housing and also at a customer forum this spring.

In addition to our heightened security review and measures taken, maintaining our daily business continued throughout the year.

Members of the Department of Facilities and Human Resources staff successfully negotiated a new union contract with the Service Employees' International Union, Local 254 (SEIU). Key changes include incorporation of a formalized performance appraisal for hourly staff, a work clothes program, acceptance of a rewards and recognition program, and tiered wages for custodians. The new, three-year contract was ratified by the union membership in January 2002.

This year significant design changes were made to the Committee for the Review of Space Planning (CRSP) structure that are already enhancing our ability to manage space and space changes in a more effective manner. Among the major aspects of this are two new appointments to CRSP. Our director of capital project development and the director of design and construction will now serve on CRSP; the latter was also appointed to the CRSP-Renovation subcommittee (RCRSP). DCS is now developing and implementing program- and project-level controls consistent with the broader accountabilities of the department.

The Capital Project Development group (CPD), which now incorporates the Drawing Information Systems team, has put in place a draft space management system for testing and further development over the next year. The system significantly increases the usefulness and analytical power of space use and characteristics information. The CPD group is also engaged in several campus-wide development efforts including transportation, Information Systems, medical services and classrooms.

The infrastructure renewal program completed its third and final year in its current form investing $45M in 60 projects. Each of these projects eliminate part of the existing backlog of building system deficiencies that, if left unchecked, could adversely impact the life of our buildings and the Institute's ability to carry out its mission of learning and research.

The Department of Facilities continued our goal to meet client needs and expectations, improve our business processes and increase environmental initiatives. Many of the steps taken reflect the five administrative themes of our executive vice president.

Client Orientation

We have organized ongoing meetings between the Repair and Maintenance managers and the Department of Housing, Registrar's Office, Campus Activities Complex, and Dining Services to be more proactive with issues, needs, and problems. These meetings have been very productive and have enhanced our level of service to these customers.

Our customer forum series continued this year with presentations by members of several service areas including Capital Projects, Design and Construction, Mail Services, and Repair and Maintenance. We anticipate continuing this well-received series in the next academic year.

In April, one of our leadership subteams met with the Administrative Advisory Council II (AAC II) to discuss their research on responsibilities for building systems management. The team, which consisted of members from different service areas as well as a customer representative, did research on specialized systems and who currently has responsibility for their maintenance and found that there is little parity at the Institute. We will continue to work with AAC II on how to resolve this issue.

Collaboration

Several members of the department have been working on the Institute's efforts to develop an environmental, health and safety management system. Our department's existing training program, inventory tracking system, and environmental team's relationship with the EHS department have been used as models for the Institute to expand upon.

By a joint effort of the Lab for Energy and Environment staff and Utilities staff, a grant proposal was developed and submitted to the Massachusetts Renewable Energy Trust for photovoltaic installations at the MIT campus and on roofs of staff members' homes. We anticipate receiving a response to our request sometime in the next year.

Multiple presentations and tours of the cogeneration plant were provided to student groups, MIT departments, and outside groups, such as Mechanical Engineering, Aeronautics and Astronautics, Architectural/Building Science, and MIT's Senior Congressional Staff Seminar. Our joint presentation with Chemical Engineering included a presentation by Professor Janos Beer, the inventor of the combustor technology, which is incorporated in our gas turbine generator.

Sustainability

MIT benefits significantly by having a highly efficient central cogeneration plant that serves most buildings on campus. The engineering and utilities groups are engaged on an ongoing basis with environmentally friendly upgrades to the central plant as well as water and energy reduction technologies in buildings throughout the campus. These initiatives have not only dramatically reduced the use of natural resources, but also have provided provisions to greatly improve the monitoring of our energy use.

As construction causes disruption on campus, we are aware of the importance of preserving or adding to green space for our community. As part of the campus beautification initiative, begun in FY2000, the department has redesigned the Vassar Street corridor from the east to the west edges of campus. This streetscape revitalization will transform this industrial throughway into a people-friendly residential street. The design, which is due to start construction this year, includes reduced automobile parking, traffic calming, new bikeways and walkways, and street trees.

This past year, the department initiated a construction and demolition debris-recycling program. This program requires contractors to maximize the recycling of construction waste on new projects and when buildings are demolished. The new system was employed on the Media Lab demolition project, resulting in 96 percent of the materials being recycled.

We continue to try and expand our campus-recycling program. We have added more sites for food scrap composting and installed compactors on the edge of campus to lower the cost of materials removal. WasteCap of Massachusetts, a non-profit company that assists companies and institutions start up or improve waste management programs, also recently reviewed the program. We are awaiting their final report due to us in July.

Accountability

Over the past year a significant effort was undertaken in the area of benchmarking and development of a net asset value (NAV) model for our physical assets. With the collaboration of the Boston Consortium and of Sightlines, a firm that specializes in the measurement of campus physical assets, we have worked to define a methodology that integrates the maintenance of facilities, the repair of deferred maintenance, the renewal of space to meet program needs, as well as the implications of adding new facilities. As an industry, higher education has focused heavily on management metrics to manage its investments, its revenue, and its recruitment. With the NAV model and benchmarking we have now begun a similar effort to measure physical asset performance. We can demonstrate that with a combination of increases in operating expenditures to address planned maintenance as well as new space, and in capital expenditures to restore assets, a long-term solution can be attained.

The department deployed a computerized timekeeping system that hourly employees use to record their time. This system has the capability of interacting with our computerized maintenance management system and SAP. It also can link directly to the payroll system. The new system will better allow us to track daily schedules, overtime, as well as sick and vacation time of the hourly staff.

Professionalism

For the past year, I have participated in the Boston Consortium's leadership program. In the coming year, we plan to expand our efforts to reach a great cross section of colleges and universities. Following are some of the professional achievements of our department.

Utilities staff members presented at the International District Energy Association (IDEA) college and university conference and annual conference, and at an energy efficiency and measurement seminar sponsored by a national engineering firm. Peter Cooper, our director of utilities, was recently appointed to serve as a director of the IDEA.

Our executive administrator, Pat Kennedy Graham, joined the AAC II group this year. She is a member of the communications subteam that reviews better ways to communicate to administrative officers about issues that affect them directly.

This year, Leader to Leader (L2L), a new management program geared toward select members of the MIT administrative staff, was unveiled. David Myers was the Facilities representative selected for this new program. A major focus and benefit of the program was on the challenges and opportunities associated with change management.

In April, MIT was pleased to host several lectures in conjunction with the American Institute of Architects (AIA) Professional Practice Conference. These lectures, which focused on distance learning and MIT's newer state-of-the-art classrooms, allowed us to highlight a number of recent renovation projects including the TEAL Classroom (26-152) and classrooms in Buildings 9 and 3.

MIT's Department of Facilities and the University of Cambridge's Directorate of Estate Management and Building Service received £10,000 from the CMI to explore collaborative opportunities within the field of facilities management. Two workshops are scheduled; the first will be held at MIT in July 2002 and the second at Cambridge in September 2002.

Landscape designer Talitha Fabricius's landscape master plan included a graphics section that just won the top award from the National Society of Environmental Graphic Designers. She continues to serve on the Boston Civic Design Commission, which reviews all major developments in the City of Boston, and she is an active member of the City of Cambridge Bike Committee.

Our directors of capital projects were participants in several activities this year. Paul Curley, director of capital construction, was a judge for the Associated General Contractors' Mass Build awards last year. Deborah Poodry, director of capital project development, has provided

management consulting to the University of Hawaii as they begin a major capital program. In addition, she served as a juror for the Associated Builders and Contractors Excellence in Construction awards and has been appointed a member of the Urban Ring Citizen's advisory committee.

Capital Projects

The Capital Projects Group, established two years ago, is charged with implementing MIT's current building program. During the past year, they managed six projects under construction, ten in the design phase, and numerous in the study phase. In addition, several milestones were accomplished, including the completion of the 224 Albany Street Graduate Dormitory (NW30) and phase one of the Dreyfus Chemistry Building (18).

In addition, the group completed the procedures manual for project management, budget and schedule tools, and updated design standards. Periodic training sessions were held for the project managers, and the group continued to enhance their reporting procedures in order to maintain strong oversight and accountability.

The new MIT Building Systems Design Handbook established LEED Silver Plus certification as the minimum standard for new capital projects. The LEED (the US Green Building Council's Leadership in Energy and Environmental Design program) standard provides national recognition for leadership in the design of environmentally friendly buildings. Currently, the Stata Center, under construction, is seeking a Gold Level Certification. Brain and Cognitive Sciences, in design, is seeking Silver Level Certification and the Sloan School of Management campus, currently in concept design, will be seeking Gold Certification. Certification occurs only when construction is complete and the project is occupied. In addition, the department is investigating sustainable design concepts for renovation projects. The department is currently developing formal process mapping and life cycle cost analysis to ensure that sustainability initiatives are incorporated in all projects.

Work continued on the following major projects during the year:

—The Ray and Maria Stata Center for Computer, Information, and Intelligence Sciences. Interior fit-out design is nearing completion. The 10-story Dreyfoos and Gates concrete towers were topped off on June 14, 2002. The exterior brick veneer has started and production is picking up speed. The early garage opening will be in the spring of 2003; total project completion in November of 2003.

—The Simmons Hall dormitory, a 10-story structure is up and the exterior metal skin and windows are nearly complete. Interior fit-out is also nearing completion for floors two through 10. Occupancy is expected in August 2002, with the first floor dining and function area following in November 2002.

—The Albert and Barrie Zesiger Sports and Fitness Center structural steel started in June 2001 and was completed in August 2001. The exterior skin followed and was fully weather tight in June 2002. Interior fit out is nearly complete and occupancy is expected towards the end of August 2002.

—At 224 Albany Street, the conversion of Building NW30 from an early 20th century mill building to efficiency apartment-style housing for 120 graduate students began in July 2000 and was occupied on August 20, 2001.

—The 70 Pacific Street dormitory, at Sidney and Pacific streets, will house approximately 750 students and will be completed in mid-July 2002.

—Vassar Street Utilities II is well underway. Simmons Hall utilities were completed in early June 2002. Zesiger Sports and Fitness Center steam line work is ongoing and expected to be complete in mid-August. The fire line service and chilled water lines have been piped into the Stata Center with the steam line expected to finish in mid-July. The redesign of the advanced energy steam line work will push the installation completion out to some time in early winter.

—The multi-phase renovation of the Dreyfus Chemistry Building, Building 18, continues. Phase one out of three was completed in June 2002. During this infrastructure renewal project, all labs, support, and office spaces will be renovated in vertical phases from one end of the building to the other while the building is two-thirds occupied. This project will provide a more efficient, safe, and code-compliant layout; address energy conservation issues; and will repair and upgrade the exposed concrete skin. Expected completion is summer of 2003.

—The design was completed in early June 2002 for the Media Lab Extension. The project is currently out to bid and site construction is scheduled to start at the end of July 2002 and will be completed in early spring 2005.

—The Brain and Cognitive Science Center (BCSC) is in the design development phase, and site construction is expected to start next spring. Expected finish of the project is the early fall 2005.

—Design for the east side of the Vassar Streetscape (between Main Street and Mass. Ave.) is complete and went out for bid in early June 2002. Construction for east side is expected to start in mid-July and be complete in May 2003. The start of the west side phase of the project (from Mass. Ave. to Audrey Street) will be delayed because of major city and state projects on Mass. Ave., Memorial Drive and in Cambridgeport starting in the spring 2003. Construction for the west side is expected to start in the fall of 2004 and complete in the spring of 2006.

Design and Construction Services

In addition to the specific projects noted below, approximately 95 space changes, both large and small, as well as numerous small interior design projects and a number of ADA accessibility projects across the campus were completed during the year. Off campus, major renovations were completed at Endicott House in Dedham to improve and increase the amenities and capacity of the kitchen facilities.

This year, Design and Construction Services (DCS) enhanced our focus on construction safety and mitigation. In consideration of an increasing number of complex renovations in existing buildings, DCS entered into a collaborative effort with Environmental Health and Safety (EH&S) personnel. DCS and EH&S staff have developed and staffed the position of construction safety officer within EH&S but assigned to DCS. The purpose for creating the position has been to ensure that MIT continues to be proactive in guaranteeing safety during construction phases of projects.

In conjunction with the Capital Project Development Group, DCS has developed and is now implementing a project-tracking system that is already increasing our capacities for communicating up-to-date information for both internal departmental use and for better communicating the status of our projects to the end users.

This year, a significant development was the collaboration between DCS and the Capital Project Development Group. Consistent with the new mandate from CRSP relative to committee structure and goals, we have focused on a holistic approach to asset management. The efforts have entailed a fundamental re-evaluation of the nature of campus improvement and, strategically, we have identified and focused on a new process of receiving, evaluating, and prioritizing work requests. The directors of Capital Project Development and DCS have partnered in the development of a new process for evaluating, assigning, and tracking projects. This effort will continue into FY2003.

Project highlights of the year included:

—The department undertook the restoration of Lobby 7, which included masonry cleaning and restoration and replacement of the skylight. For the duration of construction, Lobby 7 remained open to the public, though a complex and robust scaffolding superstructure blocked the view of the dome for months. The completion of the project has revealed a bright and elegant space whose transformation has had a profound effect on the MIT community.

—The MIT Museum in N52 underwent a significant face-lift and reorganization of its primary entrance. This initiative has brought the MIT Museum identity down to the street level by providing a generous storefront and clear and direct public entry into the facility.

—Renovations were carried out on the first floor of Building 26 to house the TEAL (Technology Enabled Active Learning) initiative which promotes the new approach to teaching core physics classes called Studio Physics.

—Major renovations were undertaken and completed on the second floor of Building 3: Lecture Hall 3-270, equipped with state-of-the-art distance-learning capabilities, and the Hatsopoulos Fluids Lab (the entire west side of the second floor). The lecture hall added significant additional capacity in support of MIT's leadership in the distance-learning environment. The Hatsopoulos Lab transformed the space into a broad, open, day-lit lab area with flexible furniture and a series of closed workspaces on the corridor side. Significant infrastructure upgrades were also accomplished with both projects. A new air-handling unit was installed on the roof of Building 3 along with new duct shafts that will provide the basis of future ventilation.

—Major renovations were carried out in the Building 66 sub-basement; the sixth floor of Building 37; and N52-4th floor, which has provided a new home for EH&S offices. Dining hall renovations and improvements are nearly complete on the first floor of Next House. This initiative is in support of the enhanced focus on student life and learning.

Finance and Accounting

The volume of construction on campus has changed the way the department does business. We have improved our vendor selection and documentation procedure while establishing more interactive relationships with departments whose work aligns with the construction process. We continue to enhance our reporting and tracking system, working to make it as automated as possible.

Operation of our core business units has been enhanced to meet known needs of the Institute community as well as looking for ways to anticipate needs that have not been articulated. Our focus in FY2002 has continued to be improving the quality and timeliness of information provided to clients. Paying greater attention to the needs of clients has had an impact on the operation of our business units and has offered an opportunity to make changes in our financial practices. To improve reporting for client services, we have actively promoted our email address, plant-finacc@mit.edu with a guarantee of same day response to our client inquiries. Our business processes have been enhanced through the use of SAPweb, ECAT, and the credit card. Purchase orders are done online reducing turnaround time from one week to two days. The use of ECAT and the credit card have eliminated nearly 3,000 invoices and companion purchase orders. Our enhancements have allowed us to reduce our accounting

clerical staff by two FTE. We will continue to look for ways to improve our purchasing and vendor payment process, which affect client accounts.

SAP training continues to be a major focus. This year, the Facilities Learning and Performance Team developed and conducted classes on SAPweb for 150 departmental requisitioners and 20 approvers.

Information Technology

The Facilities Information Technology group continues to support the wide range of departmental activity. Among the outstanding issues addressed in FY2002 were SAP enhancements and improvements to the Maximo work-tracking system in the Repair and Maintenance group. We began implementation of Kronos, a new automated time and attendance system, as a means to increase accountability in the Operational groups.

Implementation of the group's 1999 strategic plan recommendations continued in FY2002 with the reorganization of the team's interface to the client via a web-based helpdesk system. Also, we have formed a group of "Local Area Experts" providing department-wide peer support on I/T issues.

Facilities employees have developed several enhanced PC and Macintosh programs for use. The Maximo system was implemented in the Office of Residential Life and Student Life Programs. This implementation included a new web interface with real-time client reporting. In addition, modifications were made to Maximo to accommodate the new design for the combined Repair and Maintenance/ Custodial E Zone.

The group has continued to deploy desktop computers for use by all members of the organization. There are now over 400 desktop computers in Facilities for use by administrative, support, and hourly staff. Significant I/T training continues to be provided to members of the department.

Operational Units

During the past year several of our operational units underwent significant change. Our Mail Services area has an entirely new management team: Marty O'Brien, manager; Mike Fahie, day supervisor; and Jeanne Jackson, evening supervisor. This new group is reviewing current operations and will work on ways to improve service to its MIT customers.

Last year, we made a major change to the Repair and Maintenance area by creating two new manager positions. The new managers in the structural and mechanical, electrical, and piping areas are leading their teams in reducing the backlog on orders and increasing service.

In addition, we have begun a pilot program consolidating Facilities services within campus zones. On July 1, 2002 we began to test a concept of a manager in the east campus responsible for both repair and maintenance and custodial for all buildings in that section. We expect to develop a system that will provide easier access for customers and improve direction and management for those services.

In an effort to make the clean campus program a success, we have also employed a consultant to review our current cleaning program on campus. The company will review staffing, supervision, supplies, equipment and training. They will also evaluate the quality of the cleaning throughout the campus and make recommendations on how to improve services.

Facility upgrades continue to be a priority at the Bates Linear Accelerator Complex in Middleton. We have upgraded some electrical and HVAC systems, improved grounds maintenance, repaired/replaced a number of underground storage areas and installed a work tracking system. We are also in the process of upgrading the fire and life safety system. A liaison from the main campus meets with both facility and program staff weekly.

Utilities

New technology for heating distribution was installed and commissioned in the west campus to serve NW30 and Simmons Hall. It is a high temperature (240°F) water system, which is the current state-of-the-art in district heating. A steam to hot water conversion facility was installed in the former NW14 boiler room, and a piping system manufactured in Denmark was installed in the railroad right-of-way and the edge of Briggs Field. We expect to save operating and maintenance cost, and did save capital cost versus a steam system by avoiding the need for steam manholes along the route.

A new fire pump house was constructed at the Central Utility Plant, specifically to protect cooling towers and doubling the capacity of the existing central fire protection system. Piping laid in the railroad right-of-way, along with other utilities, will allow this new loop to overlay and replace the aging loop in the main group over time. Replacement of the 1968 vintage chiller plant electrical substation in 42 was also accomplished over the winter months.

Steam, chilled water, power and telecom duct banks, and hot water piping, were completed in the railroad right-of-way and Briggs Field, and municipal storm drain, sewer, and water were completed in Vassar Street itself. The other major traffic disruption, the Mass. Avenue storm drain construction by the city, was completed in May 2002, when the outfall to the river was opened and the drain put into service. MIT contributed $3 million to the city in support of this construction. MIT made an additional contribution to the city's drainage by connecting its two abandoned cooling water pipes in Audrey Street to lines in Vassar Street, all of which will be turned over to the city to provide an additional storm drain outfall.

A significant energy conservation project was the replacement of steam traps and thermostatic valves in 2,900 radiators in the main group. A smaller project was installation of controls on 25 soda vending machines to turn off power when no one is nearby. Both of these projects will be expanded in coming years.

A lab wastewater neutralizing master plan was developed to pump lab waste from several surrounding buildings to central neutralizing equipment for code compliant handling. This will reduce the number of limestone chip tanks under each lab sink, which are costly to maintain. In addition, this will reduce the amount of chemicals used, reduce daily inspection costs, and reduce permitting fees and reporting requirements. To date, Buildings 6, 8, and 18 have been piped to the central neutralizing system in 56.

Reconstruction of a steam vault in Amherst Street at W4 was accomplished, and replacement of the main electrical substation in Building 10 nears completion. Other work included 13.8kV sectionalizing switch replacements and expanded metering of chilled water steam and electricity.

The environmental team has begun working with the city of Cambridge on their project to reduce the amount of cooking grease in effluent by inspecting and upgrading campus grease traps.

Administration

Members of our staff created a new-hire orientation manual that will introduce new employees to Facilities as well as their specific work group and that also provides overall information about the Institute. The new-hire orientation program has been planned and will be piloted in the summer of 2002 for all new members to the department.

Our Learning and Performance team is updating the courses being offered to enhance skills of department personnel. In addition, an emphasis has been placed on technical training of existing mechanical systems (Andover, FCS systems) and specific team training (i.e., Operations Center and Mail Services). In an introduction to making the Department of Facilities more of a learning organization, an outside consultant, Dr. Carol Zulaf, ran a workshop for members of the department's assistant directors and the Strategic Leadership Team. The workshop began a process of exploring how all of us can make better decisions for the department and the Institute in our daily tasks.

Our Rewards and Recognition initiative has been a great success. This year, the SEIU membership voted to participate in the program. Our program consists of three levels of awards that include the Infinite Mile award ("Wonderful and Outstanding Work" award), the Criteria awards (to reinforce our department's strategic goals), and Excellence in Service (formerly called the director's award given for overall achievement). During 2002, the following awards were given to recognize our department employees: 70 WOW awards ($25 gift certificate), 10 criteria awards ($250 check), and two Excellence in Service awards ($1,000 check).

Personnel Changes

This past year, Annette Jerome joined the Human Resource team within the Department of Facilities as personnel administrator. Annette will assist with the recruitment of all positions within the department as well as work on the performance management system and other HR issues.

This spring we hired a director of engineering, Walt Henry, to lead our systems engineering group. This formerly "virtual" group will now work as a team and play a significant role in the operational needs of our current and future buildings.

The hiring of Bernard Richard as manager of mechanical, electrical, and piping rounds out the restructuring of our Repair and Maintenance section. Bernie joins the new structural manager, Dave McCormick, in leading the trades' groups providing greater technical expertise and support to the campus and other units within the Department of Facilities.

Marty O'Brien has filled the position of manager of Mail Services. He has over 12 years of experience with the United States Postal Service and provides a high degree of knowledge regarding regulations, efficiency, safety and security.

Affirmative Action Plan

Our new personnel administrator is developing a program for all open positions that will include a search plan to recruit a more diverse workforce at all levels in the department.

Victoria V. Sirianni
Chief Facilities Officer

More information about the Department of Facilities can be found online at http://web.mit.edu/facilities/.

MIT Card Office

The mission of the MIT Card Office is to actively contribute to the convenience, security, and quality of life of the entire MIT community. With a focus on customer service, the MIT ID Card serves as the Institute's universal passport to the widest possible array of campus services, facilities, and activities.

Accomplishments

For the second year in a row, the MIT Card Office was the recipient of one of the Institute's Infinite Mile awards for excellence. This award reflects the continued emphasis of the Card Office on providing the very best customer service possible to the entire MIT community. To this end, several large-scale projects were conceived and successfully

completed in the past year that will allow the MIT Card Office to enhance its services while simultaneously setting the stage for planned expansion.

The Card Office recently completed a major systems upgrade to its entire electronic access and security system. This upgrade has dramatically increased the ability of the office to proactively monitor the state of the Institute's electronic access and security equipment and allows for a vast increase in the number of electronic access and security points both on and off campus. Another benefit of the systems upgrade is the ability of the Card Office to distribute its security services functionality to individual offices and departments through the use of client stations hosted on the main Card Office infrastructure.

In another successful project, the Card Office has paved the way for a complete migration of its communication infrastructure from dedicated leased lines to network-based communication. The Card Office worked with the Information Technology Architecture Group in Information Systems to develop a virtual private network that is secure and more reliable than the previous infrastructure. As the security and convenience offered by electronic access becomes more important to the Institute, this investment in a faster, more reliable, and more inexpensive infrastructure will reap tremendous rewards.

The Card Office also renovated its physical office space in the past year, combining with the Parking Office and the Office of Campus Dining to produce a one-stop, card services customer service office. Paying close attention to detail, the new layout allows all three offices to better deliver their services in a more efficient and customer-friendly environment.

In an effort to streamline its core business, the Card Office has worked with the Dean for Student Life's Office to develop a new procedure for the creation and distribution of MIT ID cards to incoming students in the fall semester. New students now have the option of submitting an electronic ID photo before they arrive on campus. This new procedure combined with the increased efficiency of the office has allowed us to discontinue the practice of initially distributing temporary, non-photo ID cards for the first few weeks of the semester. As of this fall, all incoming students will receive a permanent, photo ID as soon as they arrive at the Institute.

Planned Projects

Looking to the future, the Card Office has also laid the groundwork for several planned projects that will benefit the entire MIT community.

Due to the success of the recent network migration and security systems upgrade projects, the Card Office is working with the Campus Police to combine various alarm systems on campus into one secure, reliable alarm infrastructure that will make use of the existing network of electronic access and security equipment maintained by the Card Office. This systems centralization will allow for more effective monitoring of security equipment and will greatly increase the reliability and responsiveness of the Institute's overall alarm and security system.

The Card Office is also looking into ways to effectively and efficiently absorb some of the smaller, independent card access systems on campus into its campus-wide system. By working closely with the various offices and departments at the Institute that currently operate their own electronic access systems, the Card Office is finding ways to meet the need of these entities to be self-sufficient while allowing them to reap the full benefits of a secure, convenient, Institute-wide, one-card system.

One of the steps that the Card Office is taking to better serve the MIT community is the adoption of proximity access technology. In the coming year, the Card Office plans to roll out a dual-technology ID card that can be used in either magnetic swipe or proximity card readers.

Staffing Changes

Daniel Michaud was promoted to the position of office manager. Former administrative assistant Michael Collins accepted a position as the house manager of Tang Hall and Westgate Apartments. Nancy Fu was hired as an administrative assistant.

Daniel L. Michaud
Manager

MIT Police

On December 10, 2001, I was appointed chief of the MIT Police Department. Previously, I had completed a 27-year career with the Massachusetts State Police, retiring at the rank of colonel and superintendent of the department. My MIT appointment was initially scheduled to take place in September 2001, but due to the tragic events of September 11, I was asked by Governor Jane Swift to assume the position of interim director of security at the Massachusetts Port Authority, Logan International Airport.

Since my appointment with the MIT Police, I have instituted the following changes in order to enhance the professional image of the department in accordance with the standing of the Institute:

—A total restructuring of the command staff, including an internal promotion to the position of deputy chief along with three new hires at the rank of lieutenant. These changes have been made with an eye towards increasing the professionalism of the department and better serving the needs of the MIT community.

—Five patrol officers were hired to bring the patrol staff to its full complement. One of these positions also included an internal promotion.

These new officers are undergoing a new department orientation program that will allow them to better serve the needs of the MIT community.

—Under the direction of Lieutenant Daniel Costa, a department honor guard was formed and was unveiled to post the colors at Commencement. This group has also participated in several community events, such as the City of Cambridge Memorial Day parade, representing the Institute in a visible and professional manner.

—MIT police vehicles, including but not limited to cruisers and motorcycles, have been redesigned to provide a highly visible and professional image. There have been several subtle changes to the patrol officer uniform intended to improve the appearance and professionalism of department members.

I am committed to these efforts to ensure that the MIT Police department continues to commit itself to providing the utmost in professionalism and service to the Institute.

During the period 2001-2002, crimes against persons decreased by three over the previous period. The 2001 total was 30 incidents. There were 120 incidents of theft of Institute-owned property, compared to 107 in 2000. Once again, computers and computer components were the most frequent type of Institute-owned property that was stolen. There were 381 incidents of personal property theft reported at sites other than residences. This compares with 356 that were reported for the previous time period. The majority of items stolen were wallets, laptop computers, and backpacks. The number of thefts from inside residences decreased to 40 for this time period from a previous total of 76. There were 16 motor vehicle thefts reported this year, which represents a slight increase from 13. The theft of bicycles increased with a total of 110 bicycles stolen as compared to 93 stolen in 2000.

MIT Police supplemented SafeRide when its early morning operations ceased by providing 288 personal safety escorts to members of the community.

The Campus Police department also provides 24-hour emergency medical services to all members of the community, as well as to Draper Laboratory and the Whitehead Institute. The total number of patients transported by the MIT Police was 819.

The Rape Aggression Defense self-defense program continued to be a popular course among the MIT community. Since its inception in 1994, a total of 636 women in the MIT community have been trained.

John DiFava
Chief of Police

Parking and Transportation Office

The MIT Parking and Transportation Office (PTO) is responsible for the following operations: parking permit allocation issuance and management, parking facility management (4,814 spaces), parking violation issuance and management, subsidized MBTA Pass program, Saferide Shuttle program, and TECH Shuttle.

The operations manager of Parking and Transportation provides day-to-day management of the department, while Standard Parking employs the remainder of the staff. There are presently 30 full-time equivalent employees working under the auspices of Parking and Transportation.

The PTO is committed to providing a high level of customer service to both internal and external customers. PTO also provides effective planning to ensure the maximum usage of all parking facilities, consideration for facility placement, construction and repairs.

Guiding Themes

In order to provide excellent customer service, we use many different methods of communication. We hold an annual parking coordinators luncheon that brings together at least one employee from every department on campus to discuss parking allocations and other issues. We maintain an email list to quickly provide messages concerning parking and transportation impacts to the community. We periodically hold a transportation fair to provide information on alternative commuting strategies and bicycle tips.

Our vision is to move the many manual PTO processes to web-based applications by transforming our Parking and Transportation web site to a commuter services web site. An application that allows departments to purchase visitor parking passes on the web will roll out in July. We initiated a discovery project to study the feasibility of a web-based parking registration system, which will be deployed in FY2003.

Collaboration was another goal of the PTO this year. Efforts were made with campus police to develop and implement a successful abandoned bicycle removal program and a new service agreement. We worked with both campus police and the state police to facilitate an auto glass etching program. During the holiday season, the PTO collaborated with campus police to run a Toys for Tickets program, which resulted in several cartons of toys donated to the Cambridge community.

The creation of a service agreement with campus police provides a sustainable platform, which will not be affected by personnel changes in either department. Service agreements with the Department of Facilities and Information Systems are in place. A service level agreement with Standard Parking is currently being worked out.

The service level agreements provide a high degree of accountability to all parties. These documents assign

responsibilities for enforcement, facility cleaning, maintenance, computing support, and all aspects of parking and transportation.

By adhering to these guiding themes we provide a valuable and well-positioned department to the Institute. The PTO will continue to investigate new technological and business process models to continually improve our processes and services in a cost efficient and productive manner.

Parking Permit Allocation, Issuance and Management

MIT is required by the Federal Clean Air Act of 1973, to provide parking to no more than 36 percent of the MIT commuting population. Due to this restriction, parking permits are not available to all who would like to have one. The total annual number of available parking permits is determined via an allocation system by the Parking Office each July. These allocations are distributed to each department for assignment. The local assignment of allocations provides a more flexible distribution system that accounts for special circumstances within that department.

There are currently 6,141 members of the MIT community with parking privileges, accounting for 8,297 stickers. There are 15 different parking permit types; 12 for employees, and three for students. Parking allocations are calculated annually and take effect around September 15 each year. All parking permits are valid from September 1 through September 15 of the following year. This means that the Parking Office issues more than 7,000 parking stickers between August 15 and September 15 annually.

Parking Facility Management

MIT currently has four parking garages and 23 open parking lots. The parking garages are the Albany Garage, the West Garage, the East Garage, and the Hayward Garage. The new Stata parking garage is scheduled to open in early 2003. All of the facilities have maintenance needs, including capital repair projects. The PTO coordinates these projects while maintaining a level of service needed to serve the Institute.

The allocation process distributes parking permits throughout all of our parking spaces on campus. For this reason, the intensity of use of each location is predetermined. In most parking locations, each space is over-allocated by a factor of .1 to .5 depending on intensity of use. The PTO must also accommodate the Institute's visitors and the occasional parking users using the same spaces. Due to the uncertainty of how many visitors and occasional users will come in each day, the lots will fill up from time to time. Overall, this approach has provided the maximum use of space possible, with minimal inconvenience to our customers.

This year we lost the Pacific Street annex lot for construction of the new graduate student residence. We have also lost portions of the West Lot, Kresge Lot, Northeast Lots and Albany Street Lots for construction of Simmons Hall, the Central Athletic Facility, and utility improvements respectively. In total, over 600 parking spaces have been taken out of service for construction needs.

Parking Violation Issuance and Management

The Campus Police as well as the PTO issue tickets for MIT motor vehicle violations on campus. There are 13 different motor vehicle violations:

Violation Type	12 Mos. Issued	Fee
Parking Over Time Limit for Zone	887	$20.00
No Permit for this Area	7,683	$20.00
Parking in Area Not Marked for Parking	702	$20.00
Blocking Roadway, Driveway, Entrance or Crosswalk	208	$30.00
Parking in a No Parking Zone	915	$30.00
Parking or Driving on Sidewalk or Lawn	274	$30.00
Blocking Fire Lane or Hydrant	94	$40.00
Parking In Reserved Space	129	$40.00
Blocking Loading Zone or Dumpster	121	$50.00
Parking in Area Reserved for Handicapped	104	$50.00
Blocking Wheelchair Ramp	26	$50.00
Driving to Endanger	3	$50.00
Speeding	4	$50.00

There were 11,150 violations issued during the 12 months ended 6/30/2002. This was a 9 percent decrease from the year before.

Subsidized MBTA Pass Program

This year MIT increased the subsidy for MBTA passes for employees and students. Previously the subsidy was $10.00 per pass. The new subsidy is now 50 percent of cost for over 90 percent of participants. The subsidy for a bus pass is 62.5 percent, for subway, combo, combo+, zone 1 and zone 2 the subsidy is 50 percent, and for zone 3 and above the subsidy is 50 percent of the face value of a zone 2 pass.

MIT has also relaxed the eligibility requirements for this program. We now allow residential students to participate in the subsidized program. Enrollment is now more than 4,800, almost evenly split between students and employees.

Saferide Shuttle Program

The Saferide shuttle program operates from 6 pm to 3 am, Sunday through Wednesday and from 6 pm to 4 am, Thursday through Saturday. There are currently five passenger vans, three of which are 12-passenger, and the other two are handicapped accessible and can seat 10 passengers.

The vans operate on fixed routes each day of the year. There are two routes that serve Boston (East and West) and two routes that serve Cambridge (East and West). The last van is put into service during heavy demand or when one of the other vans is out for service.

All members of the MIT community are eligible to use the Saferide service. However, the vast majority of passengers are students going to and from their living quarters. The service times and routes are determined by the location of student residence houses.

Use of Saferide has significantly increased in the past few years. A decision has been made to upgrade the service using minibuses to accommodate the increased demand. The Saferide shuttles currently serve 170,000 riders per year.

TECH Shuttle

The TECH shuttle was designed to provide daytime transportation to all members of the MIT community. The route operates in a loop from Kendall Square via the T stop, to Audrey Street by the Tang and Westgate residences. The shuttle runs from 7 am to 7 pm Monday through Friday.

The shuttle service was previously owned and operated by Paul Revere and coordinated by the Charles River Transportation Management Association (CRTMA). In August 2002 the shuttle service will be owned and operated by the MIT PTO. The TECH shuttle currently serves 200,000 passengers per year.

Airport Shuttles

The PTO operates Logan Airport shuttles to accommodate students leaving for Thanksgiving, winter and spring breaks. Nearly 800 students took advantage of this service during the past year.

Lawrence R Brutti
Operations Manager

More information about the Parking and Transportation Office can be found on the web at http://web.mit.edu/parking/www/.

Senior Counsel's Office

The Senior Counsel's Office offers legal services and counseling to the MIT community on MIT matters, and also can arrange for outside legal services when needed.

Our office comprises MIT's senior counsel, Jamie Lewis Keith, and three additional experienced counsel: contracts counsel Margaret Brill, litigation and risk management counsel Mark DiVincenzo, and environmental counsel Dan Winograd.

The staff are always available as problem solvers and thinking partners. We will help MIT areas accomplish their objectives; we strive to enable, not to prevent. We will empower clients with information so that they can balance risks and benefits, and make informed decisions.

Our office's expertise includes structuring, negotiating and documenting major research and other collaborations and transactions, which we do with the Office of Sponsored Programs (OSP) and the involved DLCs; export controls; privacy and information requests; contracts; litigation; mediation; investigations; employment and student issues; affirmative action; real estate and corporate law; environmental health and safety laws and permitting; and insurance and risk management issues.

Scope of Services

The scope of clients served and matters handled by the Senior Counsel's Office in FY2002 (i.e., by performing all legal work or dividing work with outside counsel, not only managing outside counsel work) includes over 30 different academic departments and 40 administrative departments. Included are:

- The provost, chancellor, DLCs, and OSP on international and other complex research collaboration agreements;
- DLCs and OSP on export controls
- International Students and International Scholars Offices and the Working Group on Information Policy and Privacy Issues of the Task Force on Campus Security on legal issues post September 11, including information on governmental investigations and compliance with new laws
- The president, chancellor, and dean for undergraduate education on affirmative action programs
- The chancellor, dean for undergraduate education, the dean for student life, the dean for graduate students, dean of science, dean of engineering, dean of architecture, and dean of the Sloan School regarding issues of student conduct and discipline, FERPA issues, government investigations and inquiries, risk management issues, contracts for services and events, employment issues, the Lemelson apprenticeship, and litigation
- The Facilities Department on contracts for design and construction, as well as on land use and environmental permitting, title issues, city of Cambridge relations and contracts, and environmental consulting contracts, in connection with campus construction and renovation projects
- Academic and administrative DLCs, including several Science DLCs, an Engineering DLC, an Architecture DLC, Human Resources, Athletic Department, and MIT Medical on employment matters, employee separation agreements, workers' compensation and benefits, policy development, and directly representing

MIT on Massachusetts and Cambridge Commissions Against Discrimination claims and hearings

- The Controller's Office, Sloan Student Financial Services, and Student Financial Services on a major loan program and related contracts, as well as on debt collection and MIT Payment Plan documents
- The provost and vice president for research on a major lease of space for academic use
- Dining Services, the Family Resource Center, and the Department of Athletics on new campus-wide dining, catering, childcare and facilities service contracts
- The Registrar's Office and DLCs on requests and subpoenas for student information (including "Buckley Amendment" issues)
- The Card Office on contracts for the expanded use of MIT's debit card, including online banking and merchant agreements
- The Alumni Association, Community Services Offices, and MIT Travel Office on contracts for services and events, dispute resolution and litigation with outside vendors, and advice regarding foreign travel risks
- Lincoln Laboratory on employment matters, security issues, contract and state procurement and real estate law issues
- The Real Estate Office and Endicott House on employment issues, real estate transactions, land-use and environmental permitting, environmental due diligence, and indemnifications and litigation
- MIT as a "potentially responsible party" at a number of superfund sites
- Many DLCs on legal process document handling (e.g., subpoenas and complaints)
- Information Systems on policy, free speech, and other issues and contracts, including cable TV
- The Committee on Discipline on process and policy compliance
- News Office on various legal issues
- The Integrated Conflict Management System Committee
- The Task Force on Emergency Preparedness and Response
- Sloan Student Activities Task Force
- Music and Theater Arts on performance-related contracts
- Bates Linear Accelerator, Athletics Department, Facilities Department, and Sailing Pavilion on environmental, health and safety compliance
- Campus Police on community issues, criminal law issues, and security issues
- Strategic management of high profile litigation in which the Institute is a party, assisting with discovery, providing assistance and information, and answering questions for the MIT community.

Highlights

The senior counsel, working with the director of sponsored programs and the controller, continued to represent MIT and the Media Laboratory under an initial agreement and a research and collaboration agreement with the Government of India and a new Indian company. The purpose of the undertaking is to "bridge the digital gap" and bring technology to the villages of India to support development of the social, educational, and economic infrastructure of the country and its people. She also worked with these colleagues to assist the Media Laboratory to explore other international collaborations.

The office provided services on a number of post-September 11 matters. The senior counsel served on the MIT Task Force on Campus Security, and she and Litigation and Risk Management Counsel served on the Working Group on Privacy. The senior counsel served on a Council on Governmental Relations Task Force and provided advice to the vice president for federal relations, vice president for research and associate provost, and the Association of American Universities on federal anti-bioterrorism legislation to assist in the development of responsible legislation that would not adversely affect research. With input from the vice president for research and director of OSP, she prepared an Information Sheet and Self-Assessment Questionnaire and provided guidance to researchers on the post-September 11 federal laws governing select biological agents. The senior counsel and litigation and risk management counsel worked with Human Resources colleagues to address issues and procedures arising from these new laws.

The senior counsel worked with the director of sponsored programs and MIT's senior officers on a number of export control issues affecting research at MIT and by MIT researchers abroad. She served as an advisor to the ad hoc Faculty Committee on Access to and Disclosure of Scientific Information.

The contracts counsel negotiated and documented over $300 million of contracts for design and construction services on MIT's major capital building projects.

The senior counsel and contracts counsel began to represent the provost and vice president for research on a long-term lease for the Institute for Soldier Nanotechnologies and Biological Engineering Division.

The senior counsel and environmental counsel continued to represent MIT in implementing its consent decree

with the EPA and the Justice Department settling a major enforcement action arising from a May 1998 inspection of MIT's campus.

The litigation and risk management counsel successfully represented a number of DLCs at federal, state and local employment and civil rights related administrative agencies and forums. In addition, litigation and risk management counsel provided legal counsel and advice to human resources and DLCs on a wide variety of discrete employee issues, including reduction in force and separation issues, preparing and negotiating separation agreements and settlement agreements. In addition, the litigation and risk management counsel provided advice on process and content regarding certain investigations in connection with particular events regarding faculty, students, and/or staff.

Controlling Legal Costs

The Senior Counsel's Office manages MIT's outside legal services funding. In FY2002, the office continued an initiative with the Controller's Accounting Office begun in FY2000 to better account for and report on legal expenditures across the Institute. Legal costs can fluctuate from year to year for a number of reasons, including unanticipated litigation and other events, more or less efficient use of inside and outside counsel, rising outside fees, and significant increases or decreases in programs. FY2000 was the first year of the Senior Counsel's Office and of more comprehensive cost tracking, and FY2002 was the first year of full staffing in the office, with additional experienced counsel in the office working the full year and creating greater capacity to provide in-house services.

With a continued exceptionally high level of real estate and other investment activity in the Treasurer's Office resulting in an approximately $870,000 increase from FY2000 to FY2002 ($200,000 increase from FY2001 to FY2002) in outside legal costs for that office, a $240,000 increase from FY2000 to FY2002 ($280,000 increase from FY2001 to FY2002) in outside legal costs for the Technology Licensing Office, and $356,500 in litigation costs for one extraordinary litigation matter which will span several years, outside legal billings at MIT were up by $350,000 from FY2000 to FY2002 ($311,000 from FY2001 to 2002). Without the cost of this extraordinary litigation, MIT's legal costs would have been about level from 2000 to 2002, even with the significant increase in costs for Treasurer's Office and TLO activities. The amounts paid to MIT's largest billing firm were down by $540,000 from FY2000 to FY2002 ($320,000 from FY2001 to FY2002), at least in part due to the ability of the Senior Counsel's Office to capably handle many matters in-house.

MIT also realized a total savings of over $880,000 in avoided outside legal fees in FY2002 in connection with legal work done by lawyers in the Senior Counsel's Office that would have been done by outside counsel if experienced inside resources weren't available. The litigation, contract, and environmental lawyers in the Senior Counsel's Office track their time spent on work that would have been sent to outside firms if the office did not exist, including work on capital projects, legal work on major policies, MCAD and other agency discrimination claims, other litigation, government investigations, major contracts and the like. Their total compensation is converted to hourly rates and compared with outside firms' hourly billable rates. MIT realized almost $1 million of savings this year on outside work done inside because inside lawyers' hourly rates are significantly below outside billable rates. Without inside counsel, there is no doubt that the increase in MIT's outside legal billings would have been at least two times greater.

Risk Management

September 11 brought risk management around the world into greater focus. The managing director for risk management/senior counsel and her staff from several departments, working with colleagues from other emergency response groups, were primary responders to the events of September 11 as they affected the MIT community. The managing director and director of Enterprise Services continued to work with all MIT emergency response departments (including the EHS Office, Facilities Department, Senior Counsel's Office, Residential Life, Dean of Student Life Office, Campus Police, News Office, and others) to raise MIT's level of safety and emergency preparedness and response, participating on the Presidential Task Force for Campus Security post September 11, and following up on issues raised by the Task Force. They sponsored a cross-departmental Safety Operations Team coordinated by the director of EHS Programs, Bill Van Schalkwyk, to plan and oversee implementation of projects and systems.

The EHS Office provided joint training for Fire Department and MIT confined space rescuers under a contract with the city of Cambridge under which the Fire Department provides confined space rescue services to MIT.

The managing director for risk management/senior counsel and institute auditor collaborated on a number of risk identification and management initiatives. The controller and director of sponsored programs also were involved. These matters included work on guidelines for complex transactions (including international transactions); work on intermediate sanctions issues and policies; work on controls within the EHS Management System design; and work for the Auditing Committee on their role in risk management review.

MIT's litigation and risk management counsel worked closely with the controller and insurance manager to

communicate with DLCs and administrative departments on best practices, promote a better understanding of MIT's insurance coverages, and assess and address potential risk throughout the Institute. The managing director for risk management/senior counsel and litigation and risk management counsel also worked with the dean for undergraduate education, dean of graduate students, provost, chancellor and head of the Travel Office, among other colleagues, on the development of international travel risk management approaches. They also provided advice and assisted in policy development related to India and Pakistan travel following very serious tensions and State Department travel warnings for those countries.

Jamie Lewis Keith
Managing Director for Environmental Programs and Risk Management/Senior Counsel

Vice President for Human Resources and Equal Opportunity Officer

The following reports of the Human Resources leaders reflect a year of progress in achieving the department's goals. Our overall purpose is to provide an array of programs and services that create a positive work environment and that support our leaders, faculty and staff in their efforts to achieve MIT's mission. Following are some highlights of HR activity this year:

The Rewards and Recognition Program is completing its second year. Both the Institute-wide Excellence awards and the locally provided Infinite Mile awards are enjoyed throughout MIT.

Leader to Leader was piloted this year. A major initiative to expand the depth and breadth of leadership capability within the Institute, this program supported the development of 18 fellows. Using both internal and external faculty, and with assistance from the Sloan School, it was quite successful.

Also piloted was the New Department Head Orientation. Designed for faculty who have been appointed as department heads, this individually tailored program acquaints them with resources at MIT that can assist with their managerial responsibilities. It is being expanded to serve new department heads in central administration as well.

On a related note, HR staff are working on the development of a New Employee Orientation that will provide a comprehensive welcome to all new employees coming to work at MIT. Scheduled to start in January 2003, this program will offer online benefits enrollment, a delightful video welcome, and an introduction to MIT's mission and a sense of the organization.

Improving the effectiveness of our pay programs is an ongoing effort in HR. This year the compensation staff have undertaken the reclassification of all support staff jobs. This is a comprehensive effort affecting 1,200 employees ultimately and will take effect in 2003. The compensation team also published guidelines for managers on handling compensation matters. This is highly valued.

Benefits enhancements are planned in the coming year. An improved vacation policy will make MIT a more competitive employer, and a new short-term disability plan will help both staff and their managers in the event of disability.

In the labor relations area, contract negotiations were successfully completed with the SEIU and the RDTEU for both campus and the Lincoln Laboratory.

We have launched a professional development series for HR professionals in both the central HR office as well as those in the departments, labs, and centers. Called HR Partners, this initiative offers enhanced communication about HR matters to these individuals as well as forums for education in our field.

We have established a new staffing and recruitment service for the Institute. The office will expand the pools of qualified applicants for available positions, streamline the application process, and emphasize minority recruitment. These efforts are assisted by the Affirmative Action/Equal Opportunity and Diversity Programs Office that also produced a report on minority staff at MIT and assisted the Lincoln Laboratory in a compliance audit by the OFCCP.

There is continued growth in services to broad segments of our community by both the Careers Planning Office and the Center for Work, Family and Personal Life. The center was key in supporting the Council on Work and Family in conducting an Institute-wide survey that explored aspects of work life here. Additionally, staff have been instrumental in developing the model and arrangements for a vastly expanded child care program for the children of MIT faculty and staff.

All HR staff, along with many from IS, FSS, Payroll and the DLCs, have been enmeshed in the implementation of a new HR/Payroll system that will replace outmoded legacy systems. The project's development has included work by numerous interdisciplinary business process teams, with review by a design review team, a policy advisory group, a sponsors' group and an executive steering committee. A massive project with many moving parts, the new system promises streamlined transaction processing and significant new capabilities in support of business decision-making.

HR staffing as of June 30, 2002, was as follows:

—Of 54 administrative staff, 42 are female and 12 are male. Of these, there are six black American females, two black American males, two Asian American females, one Asian American male and one Native American. The rest are 34 white females and eight white males.

—Of 28 support staff, 23 are female and five are male. Of these, there are three black American females, one black American male, one Hispanic American female, and two Asian American female. The rest are 17 white females and four white males.

Following are comparisons with the prior year:

	2001	2002
Administrative females	75% (36)	78% (42)
Administrative minorities	21% (10)	24% (13)
Support staff females	76% (19)	82% (23)
Support staff minorities	32% (8)	29% (8)

We were pleased to have Jean Holtman join us this year as director of benefits.

Under the leadership of Dr. William Kettyle and Annette Jacobs, the Medical Department continued to provide valuable services to a significant portion of the MIT community. A detailed summary of the department's activities is included in its own report. Highlighted in the summary are these major activities:

- Completion of the department's strategic plan, with new programs underway
- Participating in and responding to the Mental Health Task Force Report
- Improving services to patients and the community based on needs identified in the ComMITment to Care program
- Improving fiscal planning and reporting
- Completion of a staff survey on the workplace environment
- Enhancements in electronic management of clinical data

The Human Resources and Medical Departments are both pleased to serve the MIT community. We welcome comments and suggestions relative to this report or any of our programs and services.

Laura Avakian
Vice President for Human Resources and Equal Opportunity Officer

Affimative Action/Equal Opportunity and Diversity Programs Office

The Affirmative Action/Equal Opportunity/Diversity Programs Office prepares the MIT Affirmative Action Plan and consults with the Institute's departments, laboratories and centers to ensure MIT's compliance in the areas of affirmative action and equal employment opportunity. The office also provides assistance in minority recruitment, hiring, advancement and retention of underrepresented minorities and women.

Work on the HR Diversity Initiative for Minority Staff culminated with the delivery of the final report submitted in June 2002. The research conducted to investigate the minority staff issues in regard to diversity and affirmative action uncovered a series of facts that closely mirror the issues of low representation and limited professional development opportunities that have been recognized in past studies. Recommendations proposed were drawn from the review of past and current best practices reviewed in the study and the input of a cross section of MIT staff. Review, approval, and implementation of the recommendations are proposed to occur by end of year 2002.

The office assisted the Lincoln Laboratory in an Office for Federal Contract Compliance (OFCCP) desk audit of their Affirmative Action Plan. The review required the office to assist in providing reports and documents in response to the audit requests and to participate in the strategic planning meetings with the Lincoln Laboratory staff and consultants. The audit was successfully completed and the final report found Lincoln Laboratory in compliance with minor suggestions for improvements for meeting gender and minority goals.

Membership on the Committee on Campus Race Relations (CCRR) has continued in the role of co-chair for the Education Subcommittee, and the subcommittee has collaborated this year with other members of CCRR to support the development of a diversity course to be piloted in the fall of 2002. The Freshman Orientation diversity session, successfully piloted last year, is planned again for the 2002 orientation program. Efforts are underway to expand the diversity orientation to other segments of the MIT community and discussions have begun regarding a Teaching Assistants' (TA) diversity training. An IAP Open House to display MIT race relations/diversity videos and other related videos and print materials was conducted to expose members of the community to materials that can be used to inform and educate groups within MIT about the subject. Support was also given to CCRR's Race of the Future Subcommittee to the video taping of conversations among Muslim students. Their experiences within their own communities at MIT and their reactions and the effects of 9/11 have been captured on three tapes.

In support of MIT's minority recruitment efforts, the office has provided assistance as requested for specific position openings, has expanded participation in local job fairs and special interest conferences for contact with qualified applicants, and has maintained affiliation with special interest organizations for networking opportunities. These activities have added increased numbers of minority applicants to the applicant database maintained by Human Resources. This support is intended to enhance the full-service assistance expected of MIT's Minority Recruitment Program that the AA/EO Office supports and, together with the Human Resources Officers, to create additional opportunities for hiring underrepresented minorities.

The 2001–2002 MIT Affirmative Action Program was produced and prepared for dissemination to the academic and administrative management staff of the Institute in July 2002. The Tech Talk Supplement was also printed and distributed during July 2002. The office continues to modify and streamline the contents of the AAP to assist the DLC representatives to reduce the time commitment to narrative preparation and to more appropriately reflect the inclusion of only the information required under the guidelines of the Office of Federal Contract Compliance Programs (OFCCP).

Regina Caines
Director

Benefits Services

In July of 2001, SAP became the system of record for benefits administration following the successful conversion of all employee, retiree and external subscribers benefits records to the new system. During this period of data transition and auditing, the benefits staff attended SAP training and worked with FSS on testing the system for accuracy before final implementation.

Building on the successful conversion, the benefits team went to work with members of the Financial System Services (FSS) and Information Systems (IS) to build a web-based employee self services system that was used with great accomplishment during the 2002 Open Enrollment period.

The system allows employees to make changes to their benefits through a secure online system that would automatically update their record in SAP in "real time." The system also allows employees to view and create records for family members on the plans, view the cost of the plans and MIT's contribution to the benefits.

Continuing through 2002, our team again worked with FSS and members of MIT Information System and built a New Hire web application. This tool allows newly benefits eligible employees to enroll in all available health and welfare benefits online. The system also allows easy access to Fidelity Investments's web site so employees can enroll in their 401(k) Plan thus allowing new employees the capability of a more expedient full enrollment process.

In addition, another enhancement that the teams worked together on was "View Your Benefits" a SAPweb application that allows current benefits eligible employees to view their personal benefits enrollments and family member information online throughout the year.

Beginning January 2002, Benefit Concepts, Inc. became the third party administration for the Institutes Flexible Spending Accounts. Participants to these plans now are able to view their account balances, claim payment, and check history via the web or using an interactive voice response (IVR) phone system.

There were several staff changes during the year. Lauren Kaszanek and Theresa Howell joined the Benefits team as benefits administrator following the departure of Jessina Marquez and Sharon Clarke. Ms. Clarke was promoted to benefits counselor in April of 2001. Paula Hong is the newest member of the team providing support for Human Resources and Benefits in the front reception area.

Shawn Foley
Manager

Disabilities Services

The Disabilities Services Office (DSO) developed a functioning integrated disability management program for the Institute. All units of DSO are identified as having a role in supporting departments, students, employees, and Human Resource Officers regarding accommodations, leave and attendance issues. The program incorporates return to work and workplace accommodation initiatives, as well as, leave and attendance management strategies and when needed, transitioning the employee to long term disability.

The Workers' Compensation program now has a new web site and online Supervisor's Report of Occupational Injury/Illness. This ensures prompt reporting of injuries and avoids delays in necessary medical treatment and benefits due to employees. As of July 1, 2002 we have ended our relationship with Sedgwick, our former Third Party Administrator for Workers' Compensation and have contracted with Liberty Mutual/Helmsman Management Services, Inc. It is our hope that the Liberty Group will better serve MIT employees through improved case management and ensure substantially lower claims cost.

DSO continues to consult with the Department of Facilities in the area of physical access. Recent projects include the Zesiger Center and the Media Lab extension.

In October, Barbara Roberts was recognized for her work providing excellent services to students and staff by receiving the MIT Excellence award.

It became necessary to hire an additional full-time staff member (Kathleen Monagle) in DSO, whose responsibilities would be to provide services to students with disabilities. By way of this reorganization, we were able to provide prompt, comprehensive, professional services to all students with disabilities—learning, physical, and psychiatric. The result is that students benefit from having one contact person in this streamlined approach to disability accommodations. Faculty and staff also benefit from simplified communication and access.

Other benefits of a staff member dedicated to students include enhanced opportunities for collaboration with Academic Affairs and Counseling and Support Services, full time participation at Committee on Academic Performance (CAP), strengthened ties with the Freshman Office and various academic departments through discussions of individual student cases, and an enhanced role in commencement exercises via full involvement throughout the planning stages with Facilities and Guest Services.

Over the past year we have made several changes to the Long Term Disability Program (LTD). A medical consultant was hired to evaluate denied LTD claims upon appeal and the LTD Plan was finalized. We have augmented our services to work with employees immediately who are eligible or express an interest in returning to work by offering vocational assistance and training. We have also taken steps to equalize benefits for all MIT employees. Training is also being provided to supervisors on the provisions of the new plan. With

ongoing training it's our hope to provide departments, labs, and centers with the necessary information they need to assist their staff through what could be a difficult transition.

Barbara Roberts
Manager

Center for Work, Family and Personal Life

Responding to increased demand for client services and significantly greater involvement in the management of large-scale, collaborative projects, the Family Resource Center embarked on a strategic planning process this past year that culminated in a number of dramatic changes in direction and organization.

The center's new mission statement identifies its primary purpose as enriching the creativity and productivity of the MIT community by supporting the broad diversity of family structures and life experiences represented within its faculty, staff, and student populations. The center seeks to accomplish its mission through a continued combination of direct and indirect services with the highest standards and incorporate cutting-edge knowledge of the field. Thus, the center also works actively to contribute to MIT's reputation as an employer of choice, and to serve as a model for other organizations locally, nationally, and internationally.

The most visible change at the center involved the addition of the words "work and personal life" to the center's name, reflecting its increasing role in programs and projects designed to enhance quality of life at MIT, as well as its more traditional role in offering services for families. A new logotype and brochure were developed for the newly named Center for Work, Family and Personal Life.

Steps were also taken this year to broaden client services, such as by adding new seminar topics to include issues across the lifespan, as well as to streamline customer service, such as by enhancing the center's web page and appropriately increasing the roles played by the center's administrative assistant and others.

New projects were selected to focus on the collection, analysis and dissemination of information on community needs and best practice models, and on fostering collaboration and strengthening coordination of MIT's many "work/life" human services and activities, both within and outside of HR.

One such project, a new web site called MIT Lifesites, coordinated by Rae Simpson and launched in September, provides quick access to the hundreds of services, activities, programs and groups that support personal, family and community life at MIT. Information about the site was widely disseminated, and feedback has been very positive. The center provides ongoing maintenance for the site.

Rae continued to co-chair the Council on Family and Work, together with Claude Canizares, and beginning in February, Roy Welsch. A key project for the council for the year was planning, designing, administering, and analyzing a quality of life assessment, to investigate factors that contribute to a sense of community, support, and mission at MIT among faculty, staff, and students. Data gathering activities included interviews, focus groups, and an Institute-wide survey distributed in October and November, with the assistance of the consulting firm WFD Inc.

Kathy Simons continued to spearhead the campus child care expansion and reorganization initiative that will more than double current child care capacity and add infant care. Key accomplishments this year included the selection of an outside management vendor, Bright Horizons, to partner with MIT in managing campus child care programs; the completion of design development of the new Stata child care center; and creation of a new position of "Child Care Administrator" within the center to coordinate child care planning and program development, and to provide vendor oversight.

Both Kathy and Rae continue to be engaged in and in demand for local, national and international initiatives that bring recognition to MIT and its strengths as a "family-friendly employer of choice." Rae Simpson gave keynote addresses at conferences in London, Mexico, Los Angeles, and New York regarding her research on the parenting of adolescents, and she organized a leadership meeting here on campus in January to help launch a major national initiative on adolescence. In addition, she organized a special session on international issues in parenting education at the Family Support America conference in Chicago in April. Kathy's work with the New England Work/Family Association included organizing a program for the fall quarterly meeting on the importance of integrated conflict management systems to work/life efforts, and sponsorship of the event on campus.

Kathy's and Rae's respective titles changed this year as well, to manager of work/life and child care initiatives, and manager of parenting education and research. In October, Kathy and Rae were recognized for their work in creating a positive, supportive, and inclusive place for employees and faculty to work, by being among the first recipients of the MIT Excellence Award.

Erika Simmons joined the center staff in October, replacing outgoing administrative assistant Catherine Bellanti.

Kathy Simons, Manager of Work/Life and Child Care Initiatives
Rae Simpson, Manager of Parenting Education and Research

Retirement Programs

The Retirement Programs Office is responsible for retirement counseling, overseeing the administration of the MIT retirement plans, and providing investment

education to the community. In the past year, our office has counseled more than 750 employees to help them prepare for retirement.

In FY2001, the Retirement Programs Office expanded the investment education service based on program attendance and feedback. To meet the needs for fundamental investment education, "Basics of Investments" is now being presented on a quarterly basis on campus and at Lincoln Laboratory. In light of the investment climate during the past year, we offered quarterly presentations reviewing the market environment and the investment options available through the MIT 401(k) Plan. In addition, the following presentations were offered through IAP: Estate Planning Basics, Qualified Retirement Assets in Estate Planning, Understanding Your Retirement Plan, The Financial Market Today, The New Tax Law—Effect on the MIT 401(k) Plan and Basics of Investment. Total attendance at presentations exceeded 2000.

The MIT Supplemental 401(k) Oversight Committee met four times during the FY2001. This committee is responsible for monitoring the core investment options available to the 401(k) plan participants. The committee, with the support of the Retirement Programs Office, began a comprehensive review of the Single Portfolio and Asset Class investment options.

The Retirement Programs Office has initiated a review of the systems and administrative processes with the dual goal of streamlining processes and providing participants with enhanced access to information about their retirement benefits.

Ellen Weiss
Manager

Compensation

In FY2002, the Compensation Office participated in 26 external salary surveys conducted by universities, associations, and consulting groups from across the country. The office also conducted one major salary survey for faculty with 20 participants. These survey results provided a strong base for determining our market position and in developing our review allocation proposals to the MIT Corporation's Executive Committee.

Nine separate salary review allocations covering approximately 7,000 campus employees and faculty and 2,300 Lincoln Laboratory employees were administered. In an effort to assist DLCs move from a paper driven review process to an electronic review process with the implementation of HR/SAP, electronic spreadsheets were offered to DLCs to conduct their reviews this past year. A number of DLCs took advantage of this opportunity.

Compensation, HRIS, and representatives from academic areas addressed long-standing difficulties with the review process for "Other Academics." In order to test various approaches, a pilot was introduced which divided "Other Academics" into two groups. Salaried instructional appointments were to be reviewed on an annual basis and salaried research; unsalaried instructional and unsalaried research appointments were to be reviewed on a quarterly basis. Upon completion of the pilot, it was agreed that the approach worked well for salaried instructional appointments; however, there were concerns about a quarterly review process for salaried research, unsalaried instructional and unsalaried research appointments. A determination was made that, going forward (and pending the transition of DLC's to HR/SAP), the appointment process will be conducted on an annual basis for salaried instructional appointments and on a biannual basis for all others.

As the HR/Payroll Project Team works toward the implementation of SAP, Compensation staff members have been involved in various ways. During the Business Process Redesign Phase, Compensation staff were team sponsors, team leads, and team members. During this phase, current business processes were evaluated and recommendations for improved future processes were formalized. This was done in conjunction with members of the MIT community; i.e. those that will be end-users. Teams that focused on compensation practice included the Job and Position Classification and Annual Salary Review Team and the Position Management Team. Compensation continues to provide expertise and support during the "Blue Printing" stage, where team members are engaged in the day-to-day requirements of the system.

As Compensation continues to develop strong relationships with DLCs, a greater understanding of their organizational structures and compensation needs has been gained. Much discussion has taken place regarding recruitment, retention, and turnover. On an ongoing basis, the office works with departments across the Institute to review job content, recommend appropriate titles and grades, and address internal equity and external market issues. Initiatives include an analysis of I/T pay across the Institute and an approach of more uniform titling in certain administrative positions. Throughout FY2002, Compensation was involved in discussions that resulted in 90 administrative position classification or reclassification requests and 135 administrative and support promotions.

In July 2001, Compensation introduced a new set of Pay Decision Guidelines. Since then, the office has continued to revise existing guidelines and has developed new guidelines where appropriate (e.g., Off-Cycle Merit Increase Guidelines and Temporary Assignment Pay Differential Guidelines).

Compensation, in collaboration with the Medical Department, developed an approach for providing shift differentials to nurses who work evening and/or night shifts. This method of paying for off-shift work is

consistent with community practice and has assisted MIT with its recruitment and retention efforts. Compensation also collaborated with the Budget Office to provide more comprehensive budget reporting during FY2002. Specifically, through data analysis, the number of active full time employees and the costs associated with interim increases and promotions were captured for quarterly reporting purposes.

In September 2001, the Compensation Office began a review of the Support Staff structure. An Advisory Group, which included representatives from across the Institute and Lincoln, partnered with Compensation. Project goals include: updating and standardizing several support staff job descriptions and titles; updating salary ranges; determining how MIT pays in relation to other area employers; and reviewing pay equity within departments and across the Institute. Others involved in this project have included senior leadership from the schools, members of the Administrative Advisory Council II, and several members of the Working Group for Support Staff Issues.

Accomplishments to date include: development of standardized job descriptions for secretarial, administrative assistant, and clerical roles; development of position summaries for many other support staff positions; collection of market data; and development of instructions for classifying support staff jobs. Compensation conducted 38 Manager/AO briefing sessions in which the details of the support classification project and process were explained. During the summer, additional information sessions will be provided for support staff. Classification and subsequent salary adjustments will occur in the first quarter of 2003.

Barbara Jablon
Director

Human Resources Information Systems

Human Resources Information Systems' (HRIS) responsibilities include the identification, planning, and implementation of HRIS changes and updates in order to meet the strategic needs of the Human Resources Department. This encompasses meeting customer and user needs; implementing legal and other requirements; approving security access (including the data warehouse); updating and maintaining systems tables; creating and maintaining ad hoc reports; keeping current on developing HRIS technology; and developing the local area network.

HRIS staff members have participated in the numerous SAP Business Process Redesign Teams. Their role has enabled these teams to identify current Human Resources processes and make recommendations for change. Following these recommendations, HRIS was involved in the development of the blueprint documents for Organization and Compensation Management and Personnel Administration—i.e., providing detailed requirements of the organizational structure and identifying system requirements. This has, in turn, led to the configuration and conversion of the SAP Human Resources organizational structure—first in a test environment and then in a production environment. It has also given the Personnel Administration Team the information required to build the system.

HRIS has been instrumental in the redesign of the telephone directory. In past years, departments have updated employee addresses, telephone numbers, and e-mail addresses on directory forms generated by HRIS. The process has proven to be one that is extremely manual and time-intensive. The new process has been designed around an employee self-service application. This will allow employees to update their own information via SAPweb, and represents a major change in the way we do business. This new self-service application is currently in the testing mode, and will be available to employees next fiscal year.

HRIS continued its effort to redesign existing Human Resources web pages. These web pages will become more integrated; they will shift from a look that is functionally based (e.g. Benefits, Compensation, HRIS, etc) to one that is more service oriented. This new approach was identified, in part, through conversations with the intended audiences; including employees, prospective employees, managers, and retirees. These changes will provide for easier navigation.

Other HRIS efforts have included the conversion of benefits technical programs to brio query, the implementation of the new "Other Academics" annual and biannual review, and the development of web business forms and letters.

Claire Paulding
Manager

Rewards and Recognition Program

June 30, 2002 marks the end of a second fiscal year in which the MIT Rewards and Recognition Program has existed across the Institute and at the Lincoln Laboratory. As the program continues to become an integral part of MIT culture, it is meant to enhance the belief that MIT is "as excellent an employer as it is an educator." In turn, this will contribute to improved employee morale and job performance, increased quality of customer service, and better management practices.

The quantitative and qualitative feedback collected to date underscores the program's continual success in providing multiple and frequent opportunities throughout the year for MIT staff to recognize one another (both individuals and teams) for exceptional contributions to their office, their department or school, or to the Institute as a whole.

The program continues to consist of three equally important components:

—The Infinite Mile awards (typically bi-annual or annual recognition, customized around department's

particular culture, values, and goals, and administered at the local/department level). In FY2001 and FY2002, 392 administrative, support, service, sponsored research and other academic staff have been honored with individual or team awards for exceptional contributions and achievements made in the areas of: communication and collaboration, results/outcome orientation, customer/client service, community building, leadership/role modeling, and/or innovation.

—The Appreciation awards (frequent, on-the-spot "thank yous" among managers and colleagues within and outside one's own department and administered at the local/department level). Most areas are recognizing staff by presenting gift certificates and team appreciation luncheons and other recognition celebrations. It is estimated that over 2,000 staff from Main Campus and Lincoln Lab have received some form of informal recognition via the Appreciation Awards over the past 2 fiscal years.

—The MIT Excellence awards (annual recognition at an Institute-wide public celebration for exceptional contributions that align with MIT's mission, goals and values). The first annual awards ceremony was celebrated on October 3, 2001, with over 300 staff in attendance. Over 120 nominations were received. Fourteen individuals and seven teams were recognized for exceptional achievements in the following areas: Building Bridges, Fostering an Inclusive Workplace, Leading Change, Making a Difference in our Communities, Serving the Client, and Working Smarter/Getting Results. The next annual ceremony is scheduled for October 16, 2002. Closer to 130 nominations were received this year, which attests to the sustained enthusiasm and support for rewards and recognition.

In all three components of the Rewards and Recognition Program, peer-to-peer recognition, manager to employee recognition, and employee to manager recognition have been prevalent. A great number of nominations, for both team and individual awards, have been written by faculty on behalf of their remarkable staff.

The program administrator position has made it possible to provide on-going assistance in the design and revisions of customized Infinite Mile and Appreciation Awards programs, the collection and dissemination of data, the financial processing and record keeping of the budget allocations and expenditures, the delivery of professional development workshops to the local areas' key contacts and their design teams, the continual outreach to facilitate communication and share resources, the creation and maintenance of multiple forms of publicity (including a web site, Tech Talk and Faculty Newsletter articles), and the administration of the annual excellence awards celebration.

Jacqueline Stinehart
Program Administrator

Employee Relations

The primary responsibility of the Employee Relations and Human Resources Services section is to provide high-level HR consulting as well as operational/transactional support for employee/faculty appointments, transfers, promotions, annual reviews, etc. The staff consists of seven Human Resource Officers (HROs), six Human Resources Representatives (HRRs), the director of Employee Relations, and one administrative assistant.

HROs and HRRs are assigned to specific schools and organizational areas and serve as the primary point of contact and centralized HR resource for these client groups. The HRO is responsible for partnering with client groups to understand their business operation as it relates to their human resource needs, for working with the DLC to assess and address employee relations, staffing, and managerial issues and concerns. In addition, the HRO is a primary resource for HR-related questions, for counseling services, and coordinating other HR services or assistance as needed to help a DLC address or manage a particular problem or opportunity.

A large percentage of HRO time is spent counseling and advising client groups and employees on subject areas that include:

- Policy interpretation
- Risk management and employment related law
- Conflict resolution
- Sound management/business practice
- Compensation (job classification, salary determination, etc.)
- Organizational restructuring
- Discrimination and harassment issues
- Hiring process and decisions (interview skills, policy, procedure, salary offers, etc.)
- LOA and Family and Medical Leave Act concerns
- Performance management
- Corrective action consulting
- Grievance and employment-related investigations
- Identifying and coordinating referral services as necessary (EAP, Disability Services, Campus Police, etc.)

In conjunction with Staffing Services this group also provides support to departments in the processing of job listings, applicant materials and employment advertising through the MIT web site, other on-line sites, and various publications.

A major focus of Employee Relations and Human Resource Services this year was the HR/Payroll project. Debra Gratto, area director, sponsored several SAP design teams. Nearly all HRO and HRR staff served on one or more of these teams or were involved in data gathering and the evaluation of the administrative processes and systems related to the project. The specific SAP teams sponsored were: Recruitment, New hire to Orientation, Personal Transactions, Employee Transactions and Appointment Team, The Exit Team and the LOA Team.

Another initiative this year was the development of a three-pronged approach in developing stronger communication and HR partnerships between central HR and HR practitioners in the DLCs. In conjunction with OED, Employee Relations and Human Resource Services rolled out the beginning stages of the following three components:

- "HR Partners" email, an email communications designed to communicate important HR related information to the MIT HR community including the rationale related to the communication as appropriate
- "HR Forum," a half-day educational program for HR practitioners in the community. The day featured Laura Avakian, vice president of HR, who presented an overview of contemporary HR philosophy. Complex HR case studies were also presented. The cases where designed to demonstrate the myriad of issues that can be embedded in HR issues and the various resources available in HR.
- "HR Lunch and Learns" and department-based training were the third component. This included tactical training in the Family and Medical Leave Act, Interview Skills, corrective action, and affirmative action.

Employee Relations and Human Resource Services staffing changes have included the following: Che Eagle and Lucy Lui joined HR as human resources officers this year. They replaced, Susan Shannon and Mary Markel, respectively. Sue left the Institute and Mary Markel transferred to Biology as a personnel administrator. Eileen Calvey transferred to an HRR position from the Lincoln Laboratory, and Maria Santos joined the team when she transferred from MIT Press. Mary Files, HRR, was promoted to a supervisory position and transfer to IS. Anne Lafleur was hired to a newly classified position as administrative assistant. Wendy Williams was hired as manager of the new Staffing Services function that was spun off from the Employee Relations and Human Resources Services area this year. This was a retooling of the previous Recruitment Services previously under the direction of David Lee, who left the Institute in December 2001, and Debra Gratto.

Debra Gratto
Director

Labor Relations

The Office of Labor Relations is responsible for negotiating and administering the collective bargaining agreements covering approximately 1,200 MIT employees in five bargaining units. Labor Relations also oversees MIT's representation in grievance arbitrations and, in some cases, before administrative agencies in employment-related cases.

In January 2002, the Institute agreed to new three-year contracts with the Campus Bargaining Unit of the Service Employees' International Union (SEIU) and the SEIU's Lincoln Laboratory Bargaining Unit. Those agreements cover the period July 1, 2001 through June 30, 2004. In February 2002, the Institute agreed to a similar three-year contract with the Security Officers' Independent Union (SOIU) at Lincoln Laboratory, which also runs from July 2001 to June 2004. The wage increases in these contracts were consistent with MIT budgetary guidelines. The Institute's collective bargaining agreements with the Research Development and Technical Employees' Union (RDTEU) and the Campus Police Association (MITCPA) will not expire until June 30, 2003.

The number of grievances reported to the Office of Labor Relations in calendar year 2001 dropped from the previous year, from 57 to 36. During AY2002, the Office of Labor Relations heard 24 Step Three grievances. From January 1, 2001 to June 30, 2002, nine cases that had been filed for arbitration were resolved or withdrawn before the arbitration hearing, and no arbitrations were heard. In the past year, one case was filed before the National Labor Relations Board and dismissed (in favor of the Institute). In addition, two cases that had previously been pending with the NLRB were settled. Seven of the cases that were withdrawn or settled were part of a comprehensive agreement between the Institute and the Campus Police Association in May 2002.

The office is currently monitoring one case filed with MCAD; all others are overseen by the Senior Counsel's Office.

In addition, the office provided advice and counsel to departments, laboratories, and centers on issues that involve union relations, collective bargaining, employment litigation and employment policy. The office continues to try to resolve conflicts at an early stage, and to consider the concerns of both unions and management in working toward mutually satisfactory results.

Marianna Pierce
Director

Organization and Employee Development

Advancing the organizational effectiveness of MIT and its departments and promoting the professional development of the MIT community remains the mission of the

Organization and Employee Development (OED) team. Its overarching goal, to help build and support a culture of development at MIT, is supported by the interrelated activities of OED's client-focused, component teams: organization development consulting, professional development programs, career planning, and learning environment services.

Organization Development Consulting

During the last year, organization development consultants placed a particular emphasis on broadening their client base by providing increased consulting services to areas under the provost (academic departments, research labs, and centers). This effort has begun to bear fruit: the number of engagements in these areas during the first sixth months of this year was greater than the total number of such engagements the previous year. Examples of consulting services provided to areas under the provost include work with the Media Lab, Engineering Systems Division, Biology, and Electrical Engineering and Computer Science.

OED successfully completed the pilot of Leader to Leader (L2L), a leadership development program for leaders from the MIT community. In this program, L2L Fellows partner with senior leaders and MIT faculty in a proactive and systematic effort to build MIT's internal leadership capability. During the ten-month pilot program, the 18 L2L fellows who completed the program built leadership skills that are closely aligned with the strategic needs and culture of MIT.

OED also initiated a project to coordinate the New Department Head Orientation, a program piloted under the auspices of the provost and the executive vice president. This program provides a customized set of one-on-one conversations between senior Institute administrators and new heads in academic and research areas.

Organization development consultants also served as consultants in many areas of the Institute. Below are a few examples:

- MIT Libraries—helping to determine how the libraries will provide reference services in the future
- Chancellor's Office—assisting with the design and facilitation of the student leadership development planning summit
- HR Payroll Project—implementing a sustainable change management methodology, collaborating with HR, Payroll, and departments, labs, and centers toward successful implementation of the HR and Payroll SAP modules, facilitating and supporting various communications
- Environmental Programs and Risk Management/ Senior Counsel—consulting with EHS leaders on organizational issues, facilitating meetings of the EHS Working Group and ad hoc Subcommittee, facilitating the startup of the MIT Safety and Security Operations Team
- Administrative Advisory Council II (AACII)—assisting with the design and facilitation of AACII's September kick-off meeting; facilitating a forum planning sub-team.

Professional Development Programs

During the past year, OED sponsored a wide range of open enrollment professional development courses for the MIT community. OED's courses focus on the areas of leadership and management, communication, collaboration, critical thinking and problem solving, financial management and reporting, individual development, and career planning.

Over the course of the summer, fall, and spring semesters of the past year, OED offered 93 professional development courses. A total of 1,343 MIT employees and affiliates participated in these courses. OED continued to offer its courses to employees of member institutions of the Boston Consortium and, for the first time, publicized its courses to MIT alumni.

Specific professional development initiatives that OED staff undertook this past year included:

- Expanding OED's MIT Leader Seminars by adding two more senior leaders as new instructors
- Collaborating with employees of Financial Systems Services to offer a new course, "Fundamentals of Financial Management: Foundations," that teaches financial managers and administrators learn about financial management at MIT
- Expanding its leadership offerings by designing a new course entitled "Making the Distinction: Doing, Managing, Leading" that helps managers and supervisors develop strategies to manage and lead others effectively
- Designing and offering a new course, "Myers Briggs Type and Change," that helps participants understand how developing an awareness of their type preference can help them to work collaboratively with others during times of change
- Offering a pilot of a self-study web-based training course (by Harvard Business School Publishing) "Coaching," through which participants explore and examine the benefits, challenges, and techniques for useful, productive coaching

In the spring of 2002, OED hired a web content coordinator whose work intersects the four areas of OED. The web content coordinator's initial priority is to shape the OED web site into an up-to-date, dynamic resource that ultimately advances individual and organization

development of the MIT community. In an initial, temporary phase, OED's web site was revised to offer resources and tools in the areas of organization and professional development. The web content coordinator continues to build OED's web site into a sustainable resource for individuals and groups at MIT.

Career Planning

OED's Career Planning at MIT team experienced a very successful first year of operation. This multi-service career center provides career-planning services to all of MIT's employees and their organizations. Its services are designed to support MIT's commitment to help employees assume responsibility for their own successful development as well as linking that development to the strategic direction of the organizations in which they work. Employees utilize these services to enhance their careers by exploring new career directions, identifying developmental opportunities, implementing career change, and/or finding new positions.

During this past year, Career Planning at MIT staff delivered services to over 800 employees through a number of programs. These include:

- Individual career coaching/consulting to members of the MIT support staff, administrative staff, sponsored research staff, and faculty
- Brown bag series on job search skills, writing resumes and cover letters, resume critiques and networking
- Career workshops and courses
- Customized career programs for specific departmental groups
- Partnerships with departments, labs, and centers to implement career development strategies
- Career assessment tools including Pinpoint, Myers-Briggs, Holland's Self-Directed Search and Campbell Interest and Skill Inventory
- Extensive resource lending library
- Targeted promotion of tuition assistance benefits

During the past year, an Informational Interviewing Network was developed to help employees learn more about positions and departments at MIT, how other members of the community have invoked career growth and change, and what options are available. All members of the MIT community are invited to join or use this actively utilized network throughout their career exploration.

Learning Environment Services

OED's Learning Environment Team is responsible for the management and operation of the MIT Professional Learning Center (W89), administration of OED's Professional Development Programs, and the overall administrative work of OED.

The mission of the MIT Professional Learning Center continues to be to provide a quiet, clean, and pleasant environment in order to support effective training based on trainer and/or customer needs. It has seven state-of-the-art computer-training rooms and two professional development rooms.

Since its inception in 1996, utilization and demand for services of the Professional Learning Center have continued to increase. In FY2002, utilization of the Professional Learning Center's professional development rooms was 62 percent and utilization of its computer training rooms was 51 percent.

This year the Learning Environment Team collaborated with Information Systems to implement the use of laptops in the Professional Learning Center's classrooms to provide greater flexibility in classroom configurations and to support clients in delivering training on both Windows and Macintosh platforms in the same classroom.

In the area of support for OED's Professional Development Programs, the team provided registration services for all participants and administrative services for trainers who delivered 93 courses to the MIT community. Of the 1,343 participants, 119 were members of the Boston Consortium.

This year the team provided technical and administrative support for OED's pilot of a web-based training course. To date, the team has received and processed 45 account requests for the web-based training course titled "Coaching by Harvard Business School Publishing."

Margaret Ann Gray
Director

Staffing Services

In response to the recommendations of a community-wide Recruitment Team and in an effort to respond to the service needs of the Institute for a centralized staffing function, the Staffing Services Group became its own entity within the Human Resources Department during the past year.

Kristen Morreale, the first dedicated recruiter, was hired in December 2001. Jane Hamilton continues as the primary contact for hiring managers when jobs need to be posted and/or advertised, and Martha Kudzma is responsible for the approximately 5,000 resumes MIT receives on a monthly basis. Wendy Williams, with experience as both an HRO and career planning consultant, assumed the manager's role after David Lee resigned. Robert Martinez, a second recruiter, was recently hired, bringing with him not only a strong recruiting background but the advantage of speaking both Spanish and Portuguese as well.

Staffing Services has begun to offer its services on a limited basis through a pilot program with the School of Engineering. In addition, Kristen Morreale is supporting the new director of OpenCourseWare by coordinating the

recruiting process for key positions. She has also helped to fill several HR positions including the director of benefits.

The first and primary goal of the Staffing Services group is to initiate and support proactive approaches to recruiting, ensuring that MIT has a well-qualified and diverse applicant pool for all our open positions. In 2001, Staffing Services received 843 Requests for Personnel (RFP), the form that initiates the recruiting process. Through April 2002, we received 232 RFPs. Each RFP usually initiates a series of transactions, including posting the position on MIT's web site and in *Tech Talk*, coordinating advertising requests, and receiving and forwarding resumes as they are received for each open position. Tracking data, including RFPs by type and month, the number of resumes received per month, the number of vacancies, how long positions have been open, and what positions stay open for greater than 30 days, will help us to anticipate related trends and shift workloads and priorities, as well as consider continuous improvements to our processes.

Streamlining resume management and applicant tracking processes systems is a key priority. In the fall, it is highly likely that we will upgrade from RESTRAC to WebHire, a web-based system that will allow the Staffing Services staff to have almost immediate access to applicant resumes once they have been forwarded by an applicant. An effort is being made to encourage all applicants to apply online to ensure this ready access and eliminate most paper processing. WebHire can be integrated with SAP, eliminating the need for duplicate data entry of new hire information and the position and/or posting information required on an RFP. To ensure that this data will be integrated, Staffing Services has engaged SAP team project members to work with the group on workflow processes and the eventual integration project.

Collaboration between the HROs and Staffing Services is critical. However, it is just as important that we have a shared understanding of the work for which we are collectively and separately accountable. Using the Applicant Tracking and New Hire to Orientation workflow process maps developed by the SAP teams, we are continuing to clarify roles and responsibilities and note where we can add value to the recruiting and hiring process.

During the coming months, we will be exploring the feasibility of having an internal temp pool and identifying the MIT skills and qualifications that would most valued if we moved forward with this initiative. We will also be collaborating with the Affirmative Action Office to coordinate a plan outlining diversity initiatives, including the strategic placement of advertising, community outreach, and visibility at job fairs and other recruiting events.

Wendy Williams
Director

MIT Medical

The mission and values of the MIT Medical Department were re-examined and re-affirmed as part of our strategic planning process. The activities of the Medical Department—both day to day and long range are focused on meeting the healthcare needs of the MIT community with high-quality, available care at a reasonable cost.

Key points

Strategic Plan	Release in the fall of 2001—implementation programs and projects are underway.
Mental Health Task Force Report	Supplemental budget proposal submitted and approved—enhanced staffing and out-reach efforts being put in place.
ComMITment to Care	Identifying areas requiring enhancement and embarking on initiatives to improve service to our community are ongoing.
Performance Evaluation	A process to provide review and evaluation of every member of the Medical Department has been developed and is being implemented.
Enhancements in Fiscal Planning and Reporting	Reporting financial status, monitoring funds flow and effective and responsive budgeting procedures have been put in place and are being implemented and refined.
Staff Survey	We have conducted a staff survey on workplace environment as part of the strategic plan implementation. We will conduct it again in two years after some interventions and changes in how we work together to take care of the community.
Electronic Management of Clinical Data	Our practice is evolving into the electronic world of data management.

Strategic Plan

The mission, vision and values of the MIT Medical Department were examined, debated and discussed with consultative input, careful self-examination and scrutiny of the needs of our community, and information from other systems of healthcare and societal issues affecting healthcare delivery.

Four major goal areas were identified and work has begun on implementing programs and plans to achieve these goals. The goal areas incorporate several aspects:

- Student health—substantially improve service to students as well as their overall satisfaction with the Medical Department
- Workplace environment—create a more positive and effective workplace environment
- Services—enhance services through continued innovation
- Financial performance and resource management—effectively steward the resources entrusted to the Medical Department and deliver services in a cost-effective manner

The *MIT Mental Health Task Force Report* (see http://web.mit.edu/chancellor/mhtf) was released in November 2001 after a period of public review and comment. The report calls for enhanced services for students and other members of the MIT community and urges increased efforts at outreach and at collaboration across the MIT community. Based largely on the findings of the task force, which included members of the MIT Medical Department Mental Health Service, several initiatives were undertaken:

Evening hours were established for the Mental Health Service. The set up parallels the expansion of hours of scheduled services deployed by other services within the Medical Department.

A joint supplemental budget request was developed and presented. Working with Dean Larry Benedict and the office of the Dean for Student Life, the proposal outlined and demonstrated the needs for increased funding for both personnel and program development to facilitate and enhance the availability of mental health services and to increase efforts at outreach. The request was funded to support the additional personnel (mental health clinicians and health educators). Although program development was not directly funded, approval to use the fiscal reserves of the Medical Department was approved for these programs. The Medical Department is committed to work toward heeding the recommendations of the task force.

Residence support teams were established which included at least one mental health provider for each living group. Internally, three provider teams were established to promote more in-depth discussion of cases, improve collaboration around high-risk patients, and define best practice guidelines. In April 2002, a new intake system was developed which provides for a same-day phone assessment of new patients by one of three senior clinicians, scheduling of an intake appointment within a week depending upon the level of urgency, better matching between patients and clinicians, and more even distribution of cases across the service.

Responding to the recommendations of the Mental Health Task Force and in keeping with the Strategic Plan's focus on meeting student needs, the department ran advertisements in campus newspapers during the spring semester. Two of the advertisements were designed to help students identify the symptoms of stress and depression and to encourage students to seek help. A third advertisement introduced and promoted the new streamlined Mental Health intake process.

A collaborative social marketing program has begun involving the Medical Department, students, faculty, campus police, and members of the office of the Dean for Student Life. With the input of a professional agency experienced in social marketing, a campaign is being designed to meet the unique needs of the MIT community. The goals are to try to reduce the incidence and severity of risk taking activities and to lower the threshold for getting help for mental health problems, thereby enabling students to function more effectively academically and socially and to decrease the negative impact of emotional problems on students' lives.

ComMITment to Care

ComMITment to Care (C to C) principles and priorities continue to be an integral part of our strategic plan. Professionally-done patient satisfaction survey data for 2001 informed the choice of four themes for quality performance benchmarking purposes during 2002: promptness in returning phone calls, helpfulness on the phone, providing more information about delays, and exam room comfort. Medical chiefs of services and clinical coordinators, working collaboratively with staff in each area and with each other began interventions to improve performance in these areas during March. These efforts continue with results being monitored.

An introduction to C to C principles is part of each new hire orientation, and communication workshops are held for all new employees. Awards for one individual and one team who exemplify C to C behavior are given by the department at our annual department meeting.

Performance Evaluation

The principles outlined in our strategic planning process and the principles that provide the foundation for our C to C program are being incorporated into an evaluation program that applies to every member of the Medical Department.

For the first time, annual performance reviews for all clinical staff, including physicians, took place this spring. We are piloting the process this year, and with help from Judith Stein from the MIT Office of Organization and Employee Development, will be modifying the process, with input from those who participated, and develop a training program for the fall. The ultimate goals are to ensure that all Medical Department staff are reviewed annually; to relate individual goals and development plans to the department's strategic plan; and to develop clear and consistent measures for employees to understand how performance is evaluated.

Enhancements in Fiscal Planning and Reporting

During the year significant progress was made in developing methods of displaying and monitoring the complex and convoluted flow of funds of the department. Working with the Budget Office and with the Comptroller's Office, reporting systems are being developed that will more accurately and more usefully report the fiscal health of the Medical Department using the data warehouse to help report on a programmatic or lines of business basis.

In an effort to expand the concern for and involvement in fiscal responsibility beyond the department financial staff, the FY2003 budget process broadened the cast of participants to directly include service chiefs, administrative managers, and clinical managers in much more active rolls than they had previously played. Armed with data on past financial performance and current spending levels, they were asked to provide actual spending projections for the new fiscal year and to present in written form any requests for new positions, programmatic changes, and capital equipment needs for the fiscal year under consideration and three years into the future. Prior to the budget being finalized, the managers and chiefs were invited to present arguments in a public forum to support requests for additional funds, after which all participants and financial and administrative staff members were asked to vote on how they saw the pool being distributed. The process was considered by all to be a success and an effective tool in the financial education of the staff.

Staff Survey

The department recently conducted an all-employee survey regarding workplace environment, based on key issues identified in the development of the strategic plan. We were gratified that approximately two-thirds of the employees participated. Several working groups have been formed around identified issues. The survey will be conducted again in two years to help evaluate how we are doing in reaching our goals.

Enhancements in Electronic Management of Clinical Data

Evolution of our practice into the electronic world of data management continues. Documentation with the use of electronic messaging, transcribing of notes, online pharmacy documentation, online formulary, and online lab results in our system is improving the quality of the data management that is so vital a part of modern health care. Access to referring hospitals of MGH and MAH information systems and access to MIT Medical information from remote locations is also being developed.

Community Activities

Many members of the Medical Department participate in community outreach efforts, including health screening and health education programs for the MIT community, freshman orientation, new student registration, and flu vaccine clinics in the fall.

Several clinicians participate as premedical advisors for MIT undergraduates. In addition, many staff members are involved as instructors in the MIT/Harvard Health Sciences and Technology programs.

The continued participation of the members of the MIT Medical Department in the teaching activities at Harvard Medical School, Harvard teaching hospitals and nursing education programs in the area benefits those institutions as well as the Medical Department, the Institute and the community we serve.

Medical Care Activities

Evening Hours—MIT Medical heard in a number of ways from several segments of our community that there was a need for expanded hours of operation. In September 2001, in response to this request, Internal Medicine and Mental Health extended their hours until 7:00pm, four nights per week while Dental, Allergy, Dermatology, Pediatrics, Eye, and X-ray provide evening hours one-to-two times per week. The pharmacy and laboratory also remain open until 7:00pm, four nights per week for patient access and convenience.

After Hours

Howard Heller, MD

A staff of licensed physicians provides 24 hour a day, seven days a week care for the MIT community. Most of these physicians are fully trained or nearing completion of full training in Internal Medicine or Pediatrics. Many are in the course of advanced sub-specialty training at local area hospitals. In addition, a dedicated staff of nurse clinicians provides urgent and limited appointment based care.

Dental Service

Jay Afrow, DMD, MHA, Chief

During the past year the MIT Dental Service has completed the upgrading of its physical plant and added staff to meet the increasing demand for dental services. A part time hygienist, a per diem periodontist, and a per diem oral surgeon have been added to our care team. The additional staffing has reduced wait times for both oral surgery and hygiene from three months to three to four weeks. These additional clinicians have allowed the MIT Dental Service to begin offering dental implants as a restorative option for patients. Both the surgical placement and the restorative portion of the process can now be completed within the MIT Dental Service.

The Dental Service continues to increase its visibility in the MIT community. Presentations have been given by several providers on dental issues at IAP lectures, orientations, Lincoln Lab, and at other campus venues. The addition of our new oral surgeon, Dr. Bonnie Padwa, has allowed the Dental Service to increase its interactions with the MIT Department of Pediatrics. With advanced training in pediatric oral surgery, Dr. Padwa is able to provide consultations on craniofacial abnormalities eliminating the need for these patients to leave MIT Medical for evaluation.

Health Education Service

Marlisa Febbriello, MPH, and Laura Anne Stuart, MPH, Health Educators

The Health Education Service has increased its staff with the addition of two new assistant health educator positions. The service is now staffed by two health educators, two assistant health educators, and one support staff. The funding approved as a result of the Mental Health Task Force Report will allow the hiring of two additional health educators to offer more community outreach and activity.

This year, the annual Health and Wellness Fair held during orientation was greatly expanded, providing more information to incoming students on how to access health-related resources at MIT. Renovations began at MedSTOP, the satellite health education center located in the Stratton Student Center, to make it more student-friendly. The MedLINKS program continues, with 67 MedLINKS participating this year representing 16 residence halls and FSILGs. During the academic year, the Health Education service coordinated or participated in 14 campus-wide outreach events designed to raise students' awareness of health issues such as stress management, responsible alcohol use, and sexual health. Health educators also coordinated or facilitated 20 interactive workshops (primarily in residence halls and FSILGs) attended by almost 400 undergraduate and graduate students.

Health Education programs for the MIT community (including faculty, staff, retirees and students) have continued to grow. Two new programs were added over the past year. Educational "info-stops," which are displayed monthly in the E-25 atrium, provide educational materials on specific topics including stress management, nutrition, osteoporosis, and cancer prevention. The "your health" series offers free one-hour workshops and lectures that address the various health issues that are of interest to the entire MIT community. Lectures are offered at lunchtime to meet the needs of faculty and staff, and at 7 pm to meet the needs of students. Wellness Classes continue to be popular with a total of 400 participants attending one of the 46 10-week classes that were offered at MIT Medical/Cambridge and MIT Medical/Lexington. Twelve childbirth classes, and 48 parenting classes were also offered. IAP was very successful with an increase in the

average of participants per session jumping from 18 to 26. This year, 28 workshops were offered with a total of 767 participants. The car seat loan program has increased in popularity. An average of 30 car seats are on loan at all times. Health promotion bulletin boards addressing student and staff health concerns are changed monthly throughout the buildings. The boards increase awareness of healthy behaviors and resources within MIT and MIT Medical.

Inpatient Medical Service

William A. Ruth, MD

The 18-bed JCAHO accredited hospital facility continues to provide care for members of the MIT community. The facility provides management of acute illnesses that do not require the intensive care of a major hospital. Support during acute illnesses for students remains a vital function of the Inpatient Unit. It also provides post-operative care for patients following orthopedic, gynecologic, and general surgical procedures. In addition, the unit provides end of life services for MIT patients.

During the past year the renovation of the medication room was completed, ensuring more organized access to medications. We are continuing to work on improving communications between physicians, nurses, pharmacy, social service, and nutrition with weekly meetings to review patient issues.

Medical Service

David V. Diamond, MD, Chief

A new internist joined the Medical service. Along with excellent clinical skills and an interest in the care of young adults, Dr. David Shein also brought experience in the development and deployment of an electronic medical record. The triage nursing staff increased from one to three members, in order to provide better access to clinicians by appropriate triaging of phone, e-mail, and walk in clinical needs.

At the Lexington facility, neurology has been added. Members of the MIT Medical Department participated actively in the 50-year anniversary celebration and in Family Day. Members of our occupational health team worked closely with Safety and Personnel to develop preventative and incident related care.

Members of the department continue their involvement in various Institute committees such as COUHES, Committee on Biosafety, Animal Care Committee, and Ergonomic Committee. The Practice Management Team, an interdisciplinary group, organized as a result of recommendations of our ongoing ComMITment to care program, has addressed operational issues, including appointment availability, patient communications, staffing levels, and continues to coordinate innovations in patient centered services.

Mental Health Service

Peter A. Reich, MD, Chief

As part of ongoing efforts to respond to the mental health needs of the MIT community, a number of initiatives were implemented this year. In September 2001, the office hours were extended to 7 pm Monday through Thursday to better match student schedules. During its first two months, 131 new patients have come through a new intake system, and overall the numbers of new patients coming to the service have increased by 10 percent compared to last year. The walk-in service continues to be highly utilized, especially by students. On average, 38 percent of the walk-in patients were new to the service, and 71 percent of the patients were students. The high utilization by both new and existing patients and positive feedback regarding the new intake system suggest that publicity efforts have been successful and that there is more widespread acceptance of the service.

During the year, in response to the Mental Health Task Force Report, an internal capacity study was undertaken to assess the clinical and non-clinical demands on the Mental Health Service. Site visits were conducted to learn from two other select schools. This study supported the need for increased mental health and health education staffing to allow for more comprehensive care especially for the MIT student community.

During the year, the Mental Health Task Force, co-chaired by Kristine Girard, MD and Efrat Shavit, '02, presented its final report to the chancellor after facilitating a 45-day open discussion of the report in the MIT community. Broadly, the report has recommended increased staffing in the Mental Health Service, increased outreach and education including the development of a social marketing campaign over several years to address attitudes around mental health, and development of guidelines at the Institute level to foster mental well-being. A core team has been established to develop the social marketing campaign in conjunction with an outside marketing firm. The chancellor has created and charged the Mental Health Task Force Implementation Group, co-chaired by Kristine Girard, MD and Arnold Henderson, director of Counseling and Support Services, to oversee the implementation of the Task Force initiatives.

Peter Reich, MD plans to step down as chief of Mental Health effective June 30, 2002, and Kristine Girard, MD has agreed to serve as acting chief of Mental Health in the interim until a new chief is identified.

Nursing Service

Laureen K. Gray, RN, CS, Chief

Nurse practitioners and registered nurses continue to provide clinical care in the inpatient and outpatient areas of MIT Medical Department. This year, the Nursing Service has been reshaped to include three outpatient RN's. These nurses are available for direct patient care within the scope of practice of an RN. Providing patients with self-care

advice by telephone and email, and facilitating the making of appointments with the appropriate clinician are some of the activities that are involved.

Several MIT nurse practitioners and registered nurses provide supervision for graduate and undergraduate nursing students from the major colleges and universities in the Boston area. The Nursing Continuing Education Committee organized the Annual Nursing Conference Day on June 14, 2002, which focused on key topics related to the health and wellness of a college-aged community.

Obstetrics and Gynecology

Lori Wroble, MD, Chief

Dr. M. Susan Schilling joined our group November 1, 2001 at 65 percent, replacing Dr. Delli-Bovi who left June 30, 2001. Dr. Schilling came from a large hospital practice at Brigham and Women's Hospital and has settled in easily here. She was previously the chief of Harvard University Ob-Gyn Service and has experience in providing university based health care.

Our year has been hectic as we fought and negotiated our way into keeping our inpatient practice at Brigham and Women's Hospital (BWH). In spite of the new strategic goal of Brigham and Women's Hospital to decrease the hospital's deliveries and effectively down size the obstetrics service, we were able to negotiate our continued ability to use the BWH as our venue for both obstetric care and gynecologic surgery. We now anticipate continuing our 25-year association with BWH indefinitely.

Statistics for July 1, 2001–June 30, 2002

Patient Visits	9,109
Patients Cared for	4,062
Deliveries	175
Caesarean Section Rate	18.9%
Primary	13.2%
Secondary	5.7%
GYN Surgeries	63
Major	17
Minor	29
Missed Ab	17
LEEP (done in office)	8

All our practitioners continue to participate in community activities, including IAP lectures, pre-med advising, MedLINKS advising, participating in the HST Program's introduction to clinical medicine, HMS Primary Care Mentorship Program, precepting MGH Nurse Practitioner students and supervising residents at the Brigham and Women's Gyn Clinic. Our providers also participate actively on departmental committees and initiatives as well as various Brigham and Women's Hospital committees and with Harvard Medical School student testing on their Ob-Gyn rotation.

Pediatrics

Mark A. Goldstein, MD, Chief

Using the departmental strategic plan as a framework, five pediatricians and two nurse practitioners deliver care at the campus site and the Lincoln Laboratory medical offices. Pediatric clinical staff participated in campus educational activities including lectures, IAP and talks before student groups. Moreover, staff delivered presentations at the Lincoln Laboratory. In addition, members serve as educators in local, regional and national medical and nursing meetings.

A performance improvement study during the 2001–2002 year demonstrated that double the number of asthmatic children (54 percent) were offered or received the influenza vaccine compared to the previous year. A performance improvement study of newborns with jaundice began during the year and will be completed in late 2002.

The MIT Pediatric Service was a site also for instruction of nurse practitioner students, Harvard Medical Students, pediatric residents from the Children's Hospital as well as the Massachusetts General Hospital and fellows in Adolescent Medicine from the Children's Hospital.

Our campus pediatric nurse practitioner served as consultant to the MIT summer day camp and participated as a board member at the Technology Children's Center. The nurse practitioner performed home visits to on campus living groups for some pediatric patients. Nurse practitioner Pat Bartels also was presented the MIT Medical Department Infinite Mile award for community service in 2001.

With the institution of 48-hour discharges after routine deliveries at Boston hospitals, the Pediatric Service commenced very early follow ups of certain newborns. This practice has been of particular value for children of students, many of whom have little extended family support shortly after the birthing process.

Our secretarial staff, including the medical assistant, has made every effort to promote a personalized and friendly atmosphere that is inviting to our patients and families. To further achieve that goal, videotaped encounters have been utilized to promote more effective interactions with our children and their parents.

Student Health

Mark A. Goldstein MD, Chief

To improve access for students to medical care, walk in clinics were initiated on four afternoons each week. After rapid triage by a nurse, a physician or nurse practitioner evaluated the student. In addition, in response to student requests for extended hours, appointments for students to see a clinician in the office setting were established from 5:00pm–7:00pm on Monday through Thursday evenings.

Increased efforts to lower barriers to mental health care have addressed several initiatives. All incoming freshmen are now asked to answer eight questions about mental health. This information will be utilized to help the Medical Department staff understand the mental health needs of the students.

The Medical Department sponsored the spring meeting of the Charles River College Health Association, a consortium of local college and university health services. The theme of the meeting—mental health on campus—drew a large audience. The discussion was open and exceedingly helpful to the participants.

Clinical Director for Campus Life

In a fashion analogous to the structural changes underway in the office of the Dean for Student Life, a new position has been created and filled that is intended to foster enhanced connectivity between students and the Medical Department. Working more closely with other helping services on campus—dean's office, housemasters, campus police, etc.—the occupant of this position will be able to continually assess the medical and health education needs of the student community and be able to connect resources with need. Maryanne Kirkbride will assume this role on August 26, 2002.

Surgical Service

Lawrence Geoghegan, MD

The surgical service completed the first semi-annual staff evaluation.All surgical specialists met individually with the chief of service. Individual surgeons received a booklet containing data from patient satisfaction surveys, ComMITment to Care information, and activities update forms. This framed the evaluation process for each individual. The resulting discussions proved valuable to participants and the department.

MIT surgeons are participating in nationwide trials to evaluate efficacy of sentinel node mapping in breast cancer patients. Theoretically tumor cells from breast cancer will migrate to the first or sentinel lymph node in the axilla. With the use of radioactive isotopes, this node can be identified and removed. If it does not contain tumor cells the assumption is that the remaining lymph nodes will also be uninvolved. The early results are very impressive with a very low false negative rate. This data suggests that sentinel node biopsy could replace standard axillary dissection in node negative patients in the near future. This would virtually eliminate the 15 to 20 percent morbidity associated with the present operation.

The surgical service is also monitoring the new mammogram policy allowing our patients' access to the breast center at Mt. Auburn Hospital in certain recommended clinical situations where equipment and availability at Mt. Auburn will provide results quickly for both patients and clinicians.

The surgical service performed 182 major procedures in FY2002.

Performance Improvement

Ruth Fishbein, Performance Improvement/Risk Management Coordinator

MIT Medical uses evidence-based performance improvement to continuously enhance the quality of services provided to our patients. Current priority areas, consistent with the Medical Department's strategic plan, include: improving patient services; increasing patient satisfaction; and improving the workplace environment. Examples of specific activities include a Medication Safety Team looking to assure safe and effective medication administration practices, an Anticoagulation Team working with patients to assure effective management of their anticoagulation therapy, and service specific activities to improve telephone communication with patients.

Risk Management activities focus on proactive steps to reduce risk to patients and the facility and are part of MIT Medical's patient safety program.

Administrative Activities

Annette Jacobs, executive director; Shelagh Joyce, director, Information Systems; Ellen Offner, director, Health Plans, Finance, Strategic Planning and Marketing; Anthony Rogers, (retired) director, Operations; Deborah Friscino, director, Operations

The retirement of several key, long-term employees in the administrative area allowed an opportunity to review the organization to assure strength in our ability to support the strategic plan initiatives and the clinical activities of the department.

An internal candidate, Deborah Friscino, the chief pharmacist, was promoted to the position of director of operations. Her many years of experience in the department, combined with her clinical background and management and leadership skills, have made her an excellent addition to the senior management team. With Laureen Gray, director of nursing, she is developing and strengthening the clinical coordinators as a team.

Dr. Kettyle and Ms. Jacobs are building on this activity by working to develop skilled, capable teams in each service. Meetings with the entire group of chiefs of services and clinical coordinators are held regularly and with each team monthly.

Medical records now reports to Shelagh Joyce, the director of information systems, as we plan for and implement an automated clinical management system/electronic medical record.

The needs for increasing facility maintenance (E23 is twenty years old) and longer range space planning caused us to create a new full-time position—facilities manager/safety officer. Previously, these responsibilities had been divided among a number of people.

The partial retirement of Sally Wright, the personnel administrator, has provided the opportunity to recruit a trained human resources professional, who will help with the training, coaching, strengthening, and developing of all staff in the department who have management responsibilities.

Over the 2001–2002 year an effort to broaden the management model by increasing the responsibilities of service chiefs and clinical coordinators has been undertaken. Putting the decision-making process closer to the point of care has important advantages. Hopefully, this design will allow a more agile, responsive approach to meeting the needs of the community and the Institute. Part of this process has involved fostering administrative teams that are service specific and that are supported by financial, personnel, and administrative and clinical expertise.

Health Plans

Increasing enrollment, particularly among Lincoln Laboratory employees, is a goal we always maintain. During the calendar year 2001, enrollment increased eight percent overall, and 11 percent among Lincoln employees. In 2002, the staff implemented a three-tier pharmacy reimbursement for both health plans in an effort to control pharmacy costs and maintain benefit parity with other MIT health insurance benefit options. A variety of consumer information initiatives, including a new web site allowing patients to look up the reimbursement for each specific drug, kept member confusion to a minimum.

The Health Plans worked collaboratively with physician representatives from internal medicine and surgery to expand our provider network to improve access for our patients and minimize paperwork. The Health Plans office also implemented an automated customer service module, which provides a systematic method for documenting member interactions and follow-up via an automated ticker system, thereby, enhancing our capability to be responsive to members.

The Health Plans and the Clinical Services administrations continued the work of constantly monitoring and modifying benefits in the insurance plans and available services in the Medical Department setting in order to meet patient needs, maximize the use of available financial resources, and maintain a critical mass of necessary services.

Furthering that process, the outside actuary used by the Health Plans conducted an in-service for all provider staff outlining insurance principles such as adverse selection, the delicate balance of adding benefits to a plan versus the impact on affordability of premiums to support changes and the impact of high cost cases on the viability of health plans.

Communications and Marketing

In addition to the work being done relating to the Mental Health Task Force recommendations, the communications and marketing team released a major redesign of both the print and web versions of *health@mit* in November. In keeping with MIT Medical's mission to care for all the diverse MIT community, *health@mit* is one of the most widely distributed publications at MIT, sent free to all MIT community members.

The group has also collaborated closely with two undergraduate students, Rupa Hattangadi '03 and Jennifer Schymick '02, who are the co-coordinators of a major student health information web project that MIT Medical is funding and will launch in the fall of 2002. (Initial feasibility funding was provided by UROP). Designed by MIT students to reach out to MIT students, VIVO will combine:

Health information, searchable by keyword, that provides guidance for a healthy lifestyle, news on diseases, information about drug interactions, and advice on common student health concerns, interactive activities, including health quizzes and an adventure game with scenarios from MIT student life, and facts about MIT Medical, including profiles of clinicians, information on accessing services at MIT Medical, the scoop on student health insurance coverage and more.

Medical Department staff and students presented this project at a national meeting. This project will become a model for developing a similar website for health plan members.

Information Systems

The first year of running the department's new billing/claims/referral system has been completed. Manual processes have been automated, electronic data interfaces have been implemented with multiple MIT departments, and additional functionality has been realized. Additional systems and functionality will be continually evaluated and if appropriate implemented in future years.

Work is well under way to assure Medical meets the HIPAA regulations that go into effect the spring and fall of 2003. An operational assessment has been completed; from it priorities have been identified and workgroups created.

Across the MIT campus Medical has created an executive HIPAA committee—this has resulted in working collaboratively with MIT Human Resources, Senior Counsel's Office and the Dean's office. The purpose of bringing the different departments into a larger oversight group is to provide a vehicle to educate and provide assistance on HIPAA related issues that are consistent and shareable within the MIT community.

As a result of an administrative reorganization, an even closer synchronized approach to utilization of the electronic and paper patient medical record has developed. With this increased collaboration some of the goals that will be realized are—reduced redundancy of patient data storage, improved turnaround in communications between the patient and provider, and more complete patient data available to the provider at the time and venue of care.

MIT Medical has identified and acted upon the need for a full time IS trainer. This newly hired resource will coordinate all IS related training as well as conduct training sessions and competency training on all the billing and clinical applications, HIPAA regulations, and system related policies/procedures.

Appointments, Promotions and Terminations—June 1, 2001 through May 31, 2002

Appointments

Asumadu, Deborah	05/13/2002	Outpatient Nurse
Bhojani, Ratna	05/13/2002	Chief Pharmacist
Bright, Robert	03/25/2002	Facilities Manager/ Safety Officer
Carroll, Kim	11/27/2000	Inpatient Nurse
Chansky, James	09/10/2001	Social Worker
Fischer, Rita	09/10/2001	Social Worker
Fishbein, Ruth	05/01/2002	Performance Improvement/Risk Management Coordinator
Fogarty, Katherine	12/01/2001	Financial Systems Coordinator
Forgues, Lynn	09/05/2001	Triage Nurse
Forristall, David	01/01/2002	Applications/Technical Specialist
Kassel, Peter	08/15/2001	Psychologist
May, John	08/20/2001	Manager, Health Plan Enrollment & Benefit
McLaughlin, Margaret	01/21/2002	Nurse Practitioner
Mechegia, Mahlet	09/10/2001	Dental Hygienist
Morabito, Mary	11/19/2001	Nurse Practitioner
Neylon, Deirdre	01/01/2002	Assistant Health Educator
Perry, Jane	12/10/2001	Laboratory Manager
Rahim, Rahimah	11/26/2001	Triage Nurse
Recklet, Jennifer	06/01/2001	Program Coordinator, *Spouses&Partners at MIT*
Schilling, Susan	11/01/2001	Obstetrician/ Gynecologist
Shein, David	12/01/2001	Internist
Stuart, Laura	11/26/2001	Health Educator
Ward, Suzanne	03/01/2002	Optometrist
Wattendorf, Maryann	09/05/2001	Marketing Manager
Zelas, Laurie	08/01/2001	Clinical Nurse Specialist

Promotions

Friscino, Deborah	04/01/2002	Director of Operations
Girard, Kristine	08/01/2001	Associate Chief of Mental Health
Gross, Robert	01/01/2002	Chief of Eye Service
Lecorps, Yolette	03/01/2002	Manager of Medical Records

Terminations

Amsler, Linda	11/23/2001	Triage Nurse
Arnone, Laurie	08/31/2001	Physician Assistant
Baral, Gina	08/29/2001	Health Educator
Biller, Bruce	06/30/2001	Internist
Brager, Amy	03/31/2002	Psychiatrist
Cecca, Eileen (retired)	01/30/2002	Nurse Practitioner
Delli-Bovi, Laurent	06/30/2001	Obstetrician/ Gynecologist
Edwards, Rodney (layoff)	02/01/2002	Manager of Medical Records/Asst Facilities Manager
Israel, Elliot	08/01/2001	Pulmonologist
Long, Patricia	12/21/2001	Performance Improvement Coordinator
Nigro-Beland, Patricia	08/31/2001	Inpatient Nurse
Nordberg, E. David	06/30/2001	Chief Radiologist
Rogers, Anthony (retired)	04/30/2002	Director of Operations
Wittman, N. Lynn	12/31/2001	Optometrist
Wright, Janet "Sally" (retired)	06/01/2002	Manager, Administrative Services

William Kettyle, MD, Medical Director
Annette Jacobs, Executive Director, MIT Medical

Vice President for Information Systems

Information Systems (IS) fulfills an essential role in furthering MIT's core missions of education, research, and service by working in partnership with the Institute's faculty, students, and staff to apply, and help them apply, information technology (I/T) to reach their goals. To do this, IS focuses its work around four strategic themes:

- Engage clients to realize value from information technology
- Deliver I/T products, support, and services
- Operate and improve MIT's I/T environment
- Foster individual and organizational development

These themes are embodied in the IS vision—quality, service, value, leadership.

The principal goal of IS is to provide a world-class information technology environment for MIT's world-class faculty, students, and staff. To this end, IS provides "commons" services such as computing help, voice and data network connectivity, data storage, software acquisition and support, and the Athena computing environment. Services provided by IS range from strategic partnerships at the MIT-wide level to operational services and support at the departmental and individual levels. Many of IS's wide range of products, support, and services are provided at no cost to the departments, laboratories, and centers (DLCs). Others (such as telephone and network services) are provided on a cost-recovery basis or through competitive prices to cover the costs of these resources.

For many members of the MIT community, their first contact with IS is through a request for support or service. In a typical week, IS receives over 2,000 requests for help and service changes. These range from upgrading telephone and network service to installing a new office computing environment, from assisting faculty in using computers in their teaching to supporting major MIT strategic initiatives such as OpenCourseWare (OCW) and the HR/Payroll Project. Faculty, students, and staff in DLCs interact with IS in many obvious ways each day: they call the Computing Help Desk with Macintosh, PC, and UNIX hardware or software questions, or they call the Business Liaison Team (BLT) with questions about business applications. Members of the community also rely on IS in more intrinsic ways. When anyone at MIT turns on a computer—in an office, in an Athena cluster, in a lab, or in a dormitory room—and sees the network; when someone picks up a telephone receiver and hears a dial tone; when someone backs up the documents and data on their computer to storage systems in the Data Centers in Buildings W91 and W92 or otherwise uses the servers in these data centers, they are interacting with IS.

One of the major activities of this past year was a comprehensive I/T program review, initiated by the executive vice president and the provost, focusing on Financial Systems Services (FSS) and Information Systems. A program review is a collaborative and evaluative process involving self-study, client interaction, and outside peer review. Its purpose is to guide planning, program development, and service and performance standards. The review process spanned a year, from June 2001 to May 2002. FSS and IS leadership and staff supported the work of both internal and external review committees with comprehensive reports, oral presentations, and meetings to discuss the work of the two organizations.

In May, after receiving reports from the internal and external committees, the executive vice president, the provost, and the chairs of the internal and external review committees presented the review's findings to FSS and IS staff. These findings included the following:

- One of the Institute's core I/T assets is the staff in FSS and IS, whose diverse capabilities, loyalty, and dedication to the university are as strong as any the external review committee has seen elsewhere. FSS and IS staff have an exceptional service attitude; they struggle in a poorly prioritized environment.
- Computing at MIT requires more attention. The computing infrastructure is inadequate to meet all the computing needs across the Institute. Needs are greatest in network services and educational computing.
- No process, or structure, or mandate exists for identifying, discussing, and establishing strategic priorities for I/T.
- Pervasive confusion exists about IS and FSS roles and responsibilities.

The executive vice president's and the provost's initial responses to the review included a commitment to constitute an I/T Advisory Committee; a plan to initiate a benchmarking effort with Stanford University (since begun with an initial focus on the computing help desk); and an effort initiated by the Committee for the Review of Space Planning (CRSP) to study the Institute's need for distributed telecommunications rooms ("closets") to support higher network bandwidth to the desktop.

Another major activity of FY2002 was IS's second formal customer satisfaction survey. Both this survey and the one conducted in FY2001 had three purposes:

- To find out from IS customers—using a systematic process—how they rate our products, support, and services
- To document service gaps and to identify the causes for these gaps

- To use this information to identify and prioritize continuous improvement initiatives

Comparing the two surveys, we observed a dramatic improvement in our customer's satisfaction with the resolution of their problems by the IS call center. We also saw increased satisfaction with IS as a whole, with software support, with the time needed to install a telecommunications jack, and with training. These improvements are principally the result of specific process improvement efforts initiated after the 2001 survey. The 2002 survey also provides a list of improvement activities that need to be completed in order to deliver a more satisfying experience to our clients. These include:

- Extension of the wireless environment throughout the entire campus
- Increased network bandwidth to all desktops
- Improved remote network access, particularly while traveling
- Decreasing the time to repair campus network failures
- Better communication, particularly with clients who have filed trouble reports
- An improved process enabling customers to locate information about our products, support, and services and how to use them more effectively
- Providing more timely campus releases for supported commercial software

Several of these desired improvements require substantial resources—e.g., increasing the network bandwidth to all desktops—others require work, which we anticipate doing in the coming year, to improve IS internal processes. As noted earlier, CRSP has a planning study underway that is the first step in increasing the bandwidth to desktops across the campus. That study will lay the foundation for a campus-wide network renewal that will require several years of work.

During FY2002, IS staff also continued to deliver value to its clients through an impressive array of accomplishments. Highlights, organized according to five operational themes—client orientation, collaboration, sustainability, accountability, and professionalism—originally suggested by the executive vice president, are presented in the following sections.

Client Orientation

Client orientation is defined as listening to and understanding the service needs of colleagues in the DLCs, and then working with those colleagues to resolve problems and streamline processes in support of the Institute's primary academic and research missions. Much of IS's work is aligned with this theme as we strive to create clear lines-of-sight between IS service providers and our clients.

IS continued to improve its front-line support of the MIT community. During FY2002, the Computing Help Desk Team and the Business Liaison Team (BLT) together initiated some 400 cases in an average week on behalf of its clients. The average time to answer telephone calls for both the Help Desk and BLT, as well as the number of abandoned calls, decreased significantly. The Help Desk and BLT also expanded their service hours and are now available from 8:00 a.m. to 6:00 p.m., Monday through Friday, to respond to customer needs. BLT's responsibilities were expanded to include the role of central authorizer for SAP and other systems. Athena Consulting, User Accounts, and Residential Computing handled an additional 400 client cases each week with over 90 percent effectiveness for accuracy and timeliness. During the year, Web Communication Services selected and managed almost 450 spotlight headlines for the MIT home page and responded to over 1,000 requests for web help. The Usability Lab provided usability services to over 20 different projects across MIT including projects associated with SAP Employee Self-Service, Stellar, and Sloan Executive Education. The Adaptive Technology for Information and Computing (ATIC) laboratory continued to see an increase in requests for services (over 100 in-person consultations and over 50 new clients). Requests for support for individuals with repetitive strain injuries and learning disabilities continue to increase. IS Training saw continued growth in its programs and in client satisfaction; the team provided over 400 training sessions involving almost 6,800 MIT clients with a median satisfaction rating of 4.5 on a five-point scale.

IS continued improvements in the areas of human resource and staff development that have benefited both IS and MIT. This work included implementation of the EC3 (Enhancing Client Communication Competencies) program, an innovative new effort to develop IS staff customer communication competencies; continued progress in addressing internal and market equity issues; one-to-one coaching for team leaders and staff; and an improved IS new hire process. (The IS new hire process served as a reference model for the MIT new hire orientation process.)

Following a successful initial pilot, Stellar, MIT's learning management system, was used to support 17 Singapore MIT Alliance (SMA) subjects and 16 subjects in the Department of Brain and Cognitive Sciences. The next version of Stellar (1.1) has been released to the MIT community and currently supports sites for some 100 subjects.

In response to client requests, the jack installation process has been redesigned, resulting in a significant reduction—to an average of three business days—in the time required for installation of individual network jacks. IS also deployed a new web request form for jack installations and network activations to further streamline these processes.

IS implemented WebMail to provide a convenient and secure way to access email using almost any web browser from just about anywhere in the world. After being in production for less than six months, WebMail is used by some 8,000 MIT community members and is available at http://web.mit.edu/webmail/.

A number of IS projects also reflect our client orientation and response to specific client needs. These include the introduction, in collaboration with the assistant to the provost for instructional research, of a new service to support web-based surveys; improved search functionality for the MIT web site (which now has over a million URLs); a new web-based campus-wide events calendar; support for restricted email lists for each undergraduate class; and, working with the Residential Life Office, a new digital cable TV service. In addition, IS provided enabling support for a number of Discovery projects conducted in other DLCs, including Athletics I/T and web-enabled parking and registration.

Collaboration

Collaboration is teamwork, boundary-blind business processes, and open sharing of common information. Collaboration brings added value to all parties in the collaborative effort and may occur both across organizational units within an institution as well as across institutional boundaries. It is only through active collaboration that IS is able to do its work. Some examples from the year are below.

IS is a key contributor to the Open Knowledge Initiative (OKI) project, which is funded by a grant from the Andrew W. Mellon Foundation. This project will provide an open, extensible architecture as well as a set of web-enabled learning components for a wide range of educational environments. In the project, MIT's principal collaborators are Dartmouth College, Harvard University, North Carolina State University, Stanford University, the University of Michigan, the University of Pennsylvania, and the University of Wisconsin-Madison. During FY2002, OKI has made significant progress: Common Services APIs were released. Outreach events have been held to communicate OKI's focus and products. Developers at MIT and collaborating institutions have begun to build new educational service applications to test the Common Services APIs and demonstrate their value. OKI's influence on the marketplace of educational applications and learning systems solutions has become increasingly visible. The progress thus far would not have been possible without the engagement of the core institutional partners, IMS and ADL. (IMS is an international non-profit organization concerned with standards for learning systems. ADL is the Advanced Distributed Learning initiative sponsored by the Department of Defense.) In particular, work with IMS is paving the path to clarification and convergence in defining an industry-wide service architecture for educational applications. OKI's design is becoming pivotal in the progress to develop "industry" specifications and standards for learning management systems. For more information about OKI see the web site at http://web.mit.edu/oki/.

IS and the MIT Libraries collaborate to enable faculty involved in the Stellar pilots to take advantage of Ereserve services. This enables library specialists to insert Ereserve content directly into Stellar class sites. IS also collaborates with the Libraries and several departments to provide Spatial Data Services/Geographical Information System services at MIT. These services were expanded this year to include a new walk-in service in the Rotch Library. For more information see the web site at http://libraries.mit.edu/gis/.

As part of efforts to evolve MIT's academic computing infrastructure, IS and Hewlett Packard undertook a project supported by the HP-MIT Alliance to enable a mobile, heterogeneous computing environment. The project's investigation phase yielded an architecture, which added components to the existing campus architecture to provide the necessary support. Contrary to expectations, however, there was no support for implementation.

The Business Liaison Team partnered with the Administrative Advisory Council (AACII), the School of Science, and the Office Computing Practice to launch and coordinate a pilot experiment with departments in the School of Science to understand the need and to improve support for the administrative desktop computing environments in the school. The pilot is scheduled to conclude in the summer of 2002 with its results informing larger-scale approaches to desktop deployment, preventative maintenance, ongoing support, and renewal.

IS's Network Security Team, along with MIT's Campus Police, provided key support in a large multi-agency federal operation targeting an international software piracy ring. This operation, headed locally by US Customs, involved a significant on-campus effort focused on computers operated by a Department of Economics employee. IS and Campus Police were present throughout the event, assisting Customs officers, providing an Institute technical presence, and supporting the department to minimize disruption in its services. In addition, the Network Security Team worked with the FBI on two cases having MIT connections, and participated in their INFRAGARD initiative along with major businesses and government agencies in the Boston area.

IS and the Controller's Accounting Office (CAO) implemented ClearCommerce, a software package enabling MIT on-campus merchants to accept credit card payments. The Alumni Association and CAO's General Receivables are piloting the new software and related operational procedures. Work to enhance order entry, order

management, and transaction reporting for merchants was also completed. Once the pilot is completed, this service will become available to other MIT organizations that need to accept on-line credit card payments. IS and CAO also worked with other groups, including Sloan Alumni Reunions, Leaders for Manufacturing, and the Career Fair to plan an implementation of their e-commerce sites using ShopSite catalog development software, and CyberCash.

IS partnered with FSS and the SAP HR/Payroll project team to support the implementation of new processes for Benefits Open Enrollment. The IS EDI Operations Team working with the HR/Payroll team completed work with Blue Cross-Blue Shield and with Delta Dental to provide benefits enrollment data to these insurance carriers electronically as encrypted transactions, which significantly improved the timeliness and accuracy of records. IS has contributed both technical support to and "user" involvement in several other HR/Payroll project activities.

This year, IS ran the fall 2001 and summer 2002 Freshman Housing Lotteries, which were redesigned to meet new requirements provided by the Office of the Dean for Student Life. The new system permitted a summer lottery for dormitory assignments in time for Orientation, and a fall lottery for permanent dormitory assignments. This new, more robust system requires high and extended availability to authenticate pre-freshmen/freshmen; collect individual and group housing preferences; and email and display on the web the actual dorm assignments. The lotteries permitted students to establish their Kerberos identities, obtain MIT certificates, select housing preferences, and have their housing assignment returned to them before arriving on campus. IS also worked closely with the dean for undergraduate education on the Freshman Advising project and the d'Arbeloff Grants process to improve the freshman experience.

The Discovery Process increased its collaboration with other departments, laboratories, and centers by including more of their staff in projects and continuing its efforts to work with clients on I/T projects. Thirty percent of the team members for Discovery projects completed in the fourth quarter of FY2002 were from outside IS.

In fall 2001, MIT and Apple Computer, Inc. collaborated to include a development version of MIT's Kerberos authentication system in the release of Apple's new operating system, MacOS X. IS continued its work throughout the year resulting in a production version of this software, which will be released in Mac OS X later this summer. The result is a more secure platform for Macintosh users at MIT and other universities.

The COEUS project continues collaboration between IS and the Office of Sponsored Programs. The project is gaining momentum for several key initiatives with significant collaboration from other US universities. Work continues with SAP to ease use of the COEUS software with SAP Financials.

Sustainability

IS is committed to developing an information technology infrastructure that provides the foundational capabilities needed to support the teaching, learning, research, and business needs of the Institute. The goal of IS is to ensure that the MIT infrastructure is reliable, sustainable, and secure, and that it does indeed "stay the course," which is how the executive vice president describes the operational theme of "sustainability." Much of the ongoing work centers on keeping the Institute's I/T services running as well as renewing and improving those services. Key accomplishments are discussed below.

IS put into service a new 30,000 line Lucent 5ESS telephone switch—replacing equipment that had been in service for some 13 years—with little disruption to service. The new switch has sufficient capacity to meet the campus' telephony needs for the coming decade.

Work has been completed on the first two phases of a project to install single-mode fiber to all of MIT's campus buildings. When completed in FY2003, this fiber will significantly enhance the campus network capability, enabling multi-gigabit-per-second bandwidths.

The Kerberos development team delivered updates to the Kerberos product including important security fixes, improvements based on customer feedback, and an improved Application Programming Interface (API). This API significantly increases application portability for third party developers. In February 2002, MIT hosted a successful summit of representatives from industry and academia to address issues concerning advancing the Kerberos protocol standard.

With sponsorship from the MIT Council on Educational Technology, the Academic Computing Practice initiated a laptop initiative, providing computers for student use in four subjects—one each in the Departments of Architecture, Civil and Environmental Engineering, Mechanical Engineering, and Physics. In parallel, student and faculty focus groups provided valuable data on their perception of laptops as a useful technology to support academic coursework. Success of this laptop initiative was one driver in a decision to recommend that first-year students arriving in fall 2002 who were planning to bring a personal computer to campus bring a laptop.

Also, as part of its work to sustain the MIT computing environment, IS maintained 250 servers located in three on-campus data centers, replaced some 300 public and departmental Athena workstations to support MIT's educational programs, provided about 30 application software packages for use in the Athena environment, upgraded hardware and software on over 100 Athena

servers, redeployed Room E40-008 as a hot site for the recovery of administrative servers housed in W91, provided support for about 85 administrative databases, addressed needs to archive older data in SAP Financials, formalized the process for releasing the latest desktop operating system and application software, created a new team to support emerging infrastructure software— including the iXOS image archiving system used by SAP, introduced new enterprise printing capability to meet the demand for large volume print jobs, examined the feasibility of migrating the TSM backup service to a non-VM platform, and enabled users of Internet Explorer on Windows platforms to obtain MIT personal certificates.

Accountability

Accountability is that which is necessary to hold everything together. Accountability only exists when deviation from standards, obligations, and commitments is measured, and when it is both organizational and personal. Significant IS work in this thematic area is discussed below.

IS leadership focused on improving the budgeting process for FY2003 by using a zero-based budget approach. Specifically, each of IS's 55 process-based teams was asked to prepare a zero-based budget at three levels of service—barebones; sufficient to meet current demand for products, support, and service; and latent to meet new, emerging needs of faculty, staff, and students. We also asked these teams to provide performance measures, goals for improving these measures, and outside comparisons for their work. Review of these proposed budgets provided a much better understanding of the whole of IS's work, the staffing requirements to do that work, and IS's ability to meet the needs of the MIT community. On the whole we found that teams are staffed above barebones but well below sufficient, a finding that is consistent with that of the external review committee.

IS and FSS were selected to be the first MIT administrative organizations to have program reviews. As noted earlier in this report, a program review is a collaborative and evaluative process involving self-study, client interaction, and outside peer review. This review is a major step in clarifying roles and responsibilities and in establishing standards for performance and service. Its findings will provide a baseline for comparison in the coming years.

IS responded to Institute requests to be more accountable for the telephone and network rates by implementing a new internal cost accounting structure, which supports more frequent and accurate analysis of rate-based revenues and related expenses. As part of this work IS also initiated a rate review project with goals of providing a new, transparent price-setting methodology and a set of new prices that would address the needs of IS customers for stable, understandable and predictable prices; would comply with federal regulations; and would address IS business requirements of simplicity and effective cost recovery. This new model will be used in the process to set the telephone and network prices for FY2004, which will be announced early in FY2003.

IS consciously used the year's annual merit review process to measure individual performance against expectations. Steps were taken to address both the under performers as well as strong performers for whom promotions or above average pay increases were appropriate.

Professionalism

By professionalism, we mean striving for leadership across all the professions, which define us beyond our roles at MIT. IS staff serve as professional leaders in many ways and in many organizations.

IS has always presented itself as a technological leader in the higher education community. IS staff participate in, contribute to, and often play key (formal) leadership roles in various IVY+ and Internet2 groups, EDUCAUSE, the Common Solutions Group, NERCOMP, College and University Information Security Professionals, the Boston Consortium, the Internet Engineering Task Force security and calendaring standards groups, CREN, Syllabus, the New England Information and Technology Managers Group, the 5E Private Owners Association, the Association for Telecommunications Professionals in Higher Education, among others. In addition, staff provide advice on a regular basis to corporations such as Microsoft, Apple, Dell, Lucent, @Stake, and Akamai via membership on corporate advisory boards or through ongoing consulting relationships and collaborate with a wide range of other vendors and outside groups, apart from the higher education community, on technology development.

After the events of September 11, 2001, many IS staff stepped forward to help the MIT community and the Institute's leadership deal with the aftermath. This support included both technical services such as distributing email to all members of the community and initiating a new web site to collect sentiments of community members, serving as facilitators at the Killian Court gathering, providing 24-hour telephone call center coverage for the days following the event, plus establishing a back-up web site for a colleague institution that was directly effected by the tragedy.

For the past several summers, MIT's Network Security Team has hosted a summer "Security Camp" for network security teams from New England area academic institutions. The camp, which will be held again this summer, brings together individuals responsible for securing university networks and computer systems for a set of formal presentations and informal discussions, all designed to exchange information, ideas, and solutions. From time to time guests such as representatives from law enforcement and professional security consultants are

also invited. Last year some 90 individuals representing 13 universities and 11 other organizations were in attendance. Given the events of the past year, these meetings have taken on added importance.

Two members of the IS's Leadership Team—Greg Anderson and Theresa Regan—were selected to participate in the pilot session of MIT's Leader to Leader (L2L) program. L2L is a unique leadership development program for leaders from the MIT community. In the program, L2L fellows partner with senior leaders and MIT faculty to build MIT's internal leadership capability within the context of MIT's culture and aligned to the strategic needs of the Institute.

Within MIT, IS's project management expertise continues to attract other MIT organizations who wish to develop a project management capability within their own staffs. This year, project managers from the Discovery Process provided coaching and mentoring across MIT; some of these efforts led to projects both within and outside of IS such as web-enabled parking registration and help to the Publishing Services Bureau.

The Support Process continued to foster the technical skills of the DLCs' "local technology experts" by sponsoring many on-campus user groups, including the Macintosh, Windows, and IT Partners groups. In addition, IS coordinated over 70 IAP activities with a total attendance of about 1,300 faculty, students, and staff, and worked to improve the classroom technical environment at the Professional Learning Center.

IS continued to recognize professionalism within its own ranks through the MIT Rewards and Recognition Program. During the year and as part of that program, both Theresa Regan and the Computing Practices Resource Team received the Institute-wide MIT Excellence Awards for Serving the Client. In addition, IS presented the first Steven Wade Neiterman awards to Gregory A. Dancer and Jonathan M. Hunt to recognize demonstrated IT professionalism through collaborative problem solving, coaching colleagues, and team building; sharing knowledge; being a "doer;" and demonstrated commitment to MIT.

In the past year, IS staff contributed to EDUCAUSE publications, including articles in the EDUCAUSE Quarterly and in a book on HR IT practices.

IS is proud of its achievements over the past year and is committed to moving forward and continuing to improve in each of these areas in the coming year.

James D. Bruce
Vice President for Information Systems
Professor of Electrical Engineering

More information about Information Systems and its work may be found at http://web.mit.edu/is/.

Vice President for Resource Development

Resource Development encourages private philanthropy to support MIT's academic, research, and community activities. We work with four broad constituencies in this process: corporations; foundations; individuals capable of principal gifts, major gifts, and planned gifts; and non-alumni individual donors. Our efforts to attract private support from these constituencies rely heavily on the collaboration of our staff in research and information systems, communications and donor relations, finance and administration, and strategic program development. Resource Development's long-term strategic goal is to develop the overall philanthropic capacity of these constituencies to sustain a level of giving of at least $200 million annually in cash by 2004. The $1.5 billion Campaign for MIT supports this effort by focusing the Institute on the most important priorities for the future and engaging donors about their role in shaping this future.

With two years remaining, The Campaign for MIT has done this and more. As of FY2002, the campaign total stood at $1.46 billion, and even during a year of economic uncertainty, cash giving in FY2002 exceeded the $200 million mark. The Campaign for MIT has been felt across the Institute, bringing in needed support for programs, people and facilities in every school; and overall, creating 64 endowed faculty chairs, 171 endowed and expendable scholarships, and 223 endowed and expendable graduate fellowships. Fifty percent of the alumni body have participated in this effort and have given just over half the campaign total.

An important component of our organizational success is our ability to maintain a client orientation, collaborate across the Institute, emphasize sustainability in our work, and professionalism and accountability in our performance.

Resource Development cultivates philanthropic relationships targeted to key institutional priorities by carefully listening to and understanding the needs of our clients—be they corporations, foundations, alumni, prospective donors, volunteers, faculty, labs, departments, centers, MIT's senior officers, or administrative staff across the Institute. Not only is client feedback a standard part of all donor related educational programs, web-based and written communications, but it is integral to the fabric of how we conduct our business.

Collaboration is critical to effectively generate private support for needs across the Institute. Resource Development works closely with the development efforts in each school to identify, cultivate, and solicit prospects, market initiatives, and support the professional development of the school based development officers. We partner with the Alumni/ae Association to sustain and maintain the alumni database of record, ADONIS, and conduct alumni/ae surveys. Also, Resource Development has contributed to the Institute's efforts to develop key institutional messages through the Communications Operating Group, and develop and implement best practices in financial administration and human resources.

Resource Development works to sustain ongoing and increasing philanthropy from our constituencies through targeted stewardship programs and relevant, personal communication and engagement. Since the staff serves as facilitators and liaisons to cultivate these important institutional relationships, staff retention is a critical component to sustainability. We encourage long-term staff retention with careful attention to industry salary standards and an emphasis on professional development and growth on the job.

Accountability

The work of Resource Development directly effects the Institute's bottom line. Every month the Executive Committee of the Corporation reviews the monthly private support totals and overall progress of the campaign. Quarterly, the MIT Corporation and the Campaign Steering Committee do the same. Not only do we annually review and update job descriptions and measure employee accomplishments and progress toward goals in the annual departmental performance review process, but as a department our efforts are regularly reviewed and adjusted to guarantee success.

Private support for FY2002 totaled $222.9 million and included $214.7 million in gifts, grants, and bequests, and $8.2 million in support through membership in the Industrial Liaison Program. This compares with $200.8 million in 2001, $233.6 million in 2000, $209 million in 1999, and $143.9 million in 1998. Gifts-in-kind for the past year (principally gifts of equipment) were valued at $5.7 million. By source, gifts from alumni totaled $76.3 million; non-alumni friends, $14.3 million; corporations, corporate foundations, and trade associations, $48.8 million; foundations, charitable trusts, and other charitable organizations, $66.7 million; and others, $8.6 million.

Expendable and endowed funds were designated as follows: $31.1 million in unrestricted support; $104.5 million for research and education programs, $20.2 million for faculty salaries; $17.8 million for graduate student aid; $10.5 million for undergraduate student aid; $9.7 million in undergraduate education and student life; $19.3 million in building construction funds; and $1.6 million pending designation.

During the year, Resource Development promoted five women and six men. Twelve open staff positions were filled, eight positions by women and four by men, one of whom is Hispanic. Nine open support staff positions were filled, all are women, including one Hispanic, two Asians, and one

African-American. Resource Development continued its effort to recruit qualified women and minority candidates by working closely with Human Resources and others to identify new venues for recruitment. We also continued our active participation in the CASE Minority Fellowship Program to encourage professional development in fundraising among diverse constituencies.

Director of individual giving George Ramonat retired from MIT, concluding 15 years of service to MIT. After 16 years of service, John S. Wilson, left his position as director of foundation relations and school development services to become the senior assistant vice president at George Washington University. John E. Oldham returned to MIT after a 12-year absence to become the new director of foundation relations and school development services.

Barbara G. Stowe
Vice President for Resource Development

The Campaign for MIT

At the conclusion of the fifth year of The Campaign for MIT, the campaign reached $1.46 billion, achieving 97.4 percent of its goal with two years to go. Despite a philanthropic climate influenced by both national tragedy and a slowing economy, fundraising to the campaign continued at the same pace established early in this effort. With $261.9 million in new gifts and new pledges added to the campaign this year, this year stands in the top three of The Campaign for MIT.

When measured across key campaign priorities, this effort is well ahead of schedule in most areas—faculty chairs, $162.8 million achieved, exceeding the $150 million goal; scholarships and other undergraduate aid, $95.3 million raised towards a $100 million dollar goal; undergraduate education and student life, $53.4 million raised toward a $100 million goal; graduate fellowships, $129.8 million raised toward a $200 million goal; research and education programs, $565.7 million achieved, exceeding a $550 million goal; construction and renovations, $ 275.3 million raised toward a $300 million goal; unrestricted purposes, $138.2 million achieved, exceeding a $100 million goal; and $40 million still pending designation.

As The Campaign for MIT nears the $1.5 billion goal, we continue to work toward achieving the two other criteria important to the success of this effort—raising funds for targeted areas with the support of MIT alumni capable of gifts of all sizes. In all areas of our work with staff, volunteers, alumni/ae, and established and prospective donors, we continue to make every effort to acknowledge the positive effects of giving to MIT, highlight key under-funded campaign priorities while surfacing and involving potential prospects who can give at all levels to support the future of MIT.

Stephen A. Dare
Director

Office of Campaign Giving

The Office of Campaign Giving (OCG) cultivates, solicits, and stewards alumni and friends capable of making gifts of $50,000 or more to The Campaign for MIT. OCG field staff work closely with the senior administration, the deans of the schools, the Office of Principal Gifts and other offices in Resource Development, the Alumni/ae Association and volunteers to contact and solicit 4,000 identified prospects and donors over the course of the campaign. Each OCG gift officer works with about 150 active prospects to collectively manage approximately 2,000 prospective donors from around the country during the fiscal year.

This year, OCG continued to build MIT's donor base by involving and soliciting donors and prospective donors in partnership with volunteers on the Corporation Development Committee and the Campaign Network, and in collaboration with development staff and senior officers across the Institute. Cultivation events were held throughout the country to expand MIT's outreach to prospects and educate alumni and donors about key campaign priorities. Program topics included: athletics, urban studies, cancer research, comparative media studies, the MIT International Science and Technology Initiatives program, environment, and economics. Six technology breakfasts were organized in New England and Silicon Valley. On-campus breakfasts and luncheons with the deans of several schools were held to acquaint new prospects with school initiatives. Volunteer meetings were held in Boston, New York, and San Francisco. OCG staff worked with the Office of Gift Planning and the Alumni/ae Association to educate constituencies on planned giving vehicles, oversaw the Emma Rogers Society to involve widows of MIT alumni, and directly supported fundraising efforts for the arts at MIT.

In addition to continuing to reach out to MIT's major gift donors, this year OCG focused on building strong relationships with MIT faculty, senior officers, and administrators to develop and implement fundraising strategies for emerging campaign initiatives such as biological engineering, student life and learning, and neuroscience.

David A. Woodruff
Director

Office of Communications and Donor Relations

The Office of Communications and Donor Relations (COMDOR) supports MIT's fundraising efforts with editorial content, marketing initiatives, stewardship of donors, and event coordination. Led by Laure A. Morris, the staff continued to focus on two primary areas—the enhancement of stewardship and recognition efforts

for campaign donors and the marketing of institutional priorities related to The Campaign for MIT.

COMDOR continued to build the stewardship program to continue to inform as many donors as possible about the effects of their philanthropy. With nearly 600 customized stewardship plans for MIT's most generous donors now in place, COMDOR expanded the stewardship effort to recognize donors to new fund-based initiatives. Personalized letters from the provost were sent to approximately 80 major donors of unrestricted funds and a comprehensive strategy for Institute-wide stewardship of fellowship funds was developed and initiated in cooperation with the Provost's Office and the Graduate Students Office. In collaboration with Student Financial Services, COMDOR produced annual reports to donors on 222 individual scholarship funds and 68 class scholarship funds. Nearly 1,000 personalized gift acknowledgement letters and other letters of appreciation to donors from the Institute's senior officers were produced. A new stewardship resource guide was made available to Resource Development staff and an internal training session on stewardship strategy and tactics was offered.

Membership in the Catalyst Society, the recognition society for campaign donors of $100,000 or more, increased by 89 to a total of 434. Of these, senior officers, faculty, volunteers or staff has presented 98 members with the Catalyst Society gift in personal visits. The first published list of Catalyst Society membership appeared in the July 2001 issue of *(CR)²*, the campaign newsletter.

COMDOR coordinated approximately 45 cultivation and stewardship events on campus and throughout the country, nearly doubling the number offered the previous year. These events included dedications, dean's breakfasts, campus visits, Tech Breakfasts in Cambridge and California, and dinner events in private homes. Another 22 stewardship events were organized for scholarship donors and recipients. The event planning process for Resource Development was documented and internal training sessions were held to expand the staff's capacity to coordinate the growing number of events.

Marketing efforts this year included the new Giving to MIT web site, a collaborative effort with the Alumni Fund, and the campaign publication Student Life and Learning at MIT. The campaign newsletter, (CR)2, issued three editions to 6,000 prospective donors promoting a total of six campaign priorities. Two editions of *Spectrum* were produced for about 40,000 readers with cover packages on the MIT International Science and Technology Initiatives program and biological engineering. COMDOR also published MIT Facts 2002 and Fast Facts, a monthly electronic newsletter for key volunteers, and 10 versions of the Donor Profiles in *Technology Review*.

COMDOR initiated five focus group discussions this year to better understand the impact of campaign messages on individual donors and prospects. Message strategy for the final two years of the campaign is being shaped according to the themes identified in those discussions.

Laure A. Morris
Director

Office of Corporate Relations

Directed by Karl Koster, the Office of Corporate Relations (OCR), which includes the Industrial Liaison Program (ILP), creates and strengthens mutually beneficial relationships between MIT and corporations worldwide. In FY2002 total corporate cash gifts to the Institute reached $48.8 million. Revenues from the ILP totaled $8.2 million, the best result in the past 11 years. In addition, approximately half of ILP members financially supported MIT through additional gift, grant, and research engagements.

Corporate and institutional partnerships continued to experience ongoing success in FY2002, characterized by the early renewal of the MIT-Ford partnership at a level of $3 million per year for five years, and the establishment of a five-year, $50 million-plus collaboration between MIT, government, and industry with the MIT Institute for Soldier Nanotechnologies.

OCR's priorities over the year—the faculty liaison plan, retention and cultivation of ILP members, solicitation and stewardship of a range of corporate and institutional collaborations—enabled continued success in a year challenged by economic recession and a troubled geo-political environment.

Karl F. Koster
Director

More information about the Office of Corporate Relations and the Industrial Liaison Program can be found on the web at http://ilp.mit.edu/ilp

Office of Development Research and Systems

Under the direction of Shelley Brown, the Office of Development Research and Systems (ODRS) provides research, information management, technology and training support to Resource Development and its partners in The Campaign for MIT.

Research activities continued to identify new prospects and track new information about existing and potential donors. ODRS identified close to 400 alumni with the potential to make a campaign commitment of $50,000 or more in the next five years through commercial databases, clipping services, peer screening meetings with faculty and alumni, industry-focused studies to identify alumni founders and

leaders of emerging and fast-growing companies, and ongoing assessment of geographic markets. Many hundreds more were identified with the potential to make a less substantial commitment either during or after the current campaign period. Building on data gathered through the 2001 Alumni Survey, the department kicked off the first phase of an inquiry to update the MIT-related Founders Study that will be rolled out during FY2003.

To facilitate solicitation and stewardship activities of the staff, senior officers, and volunteers, ODRS produced over 1,100 research reports, including 121 specialized back-ups for the senior officers.

Information Systems staff continued to offer dynamic support of systems, information, and users to expedite fundraising activity. Key systems development projects included the incorporation of a new presidential acknowledgement module within ADONIS, enhanced stewardship tracking and reporting, and new reports and windows to incorporate Alumni Survey information.

The departmental fileserver, ADONIS (the alumni/development on-line information system), and most other software products used by the department were upgraded. New documentation was developed to support these upgrades and 250 users were retrained. Additionally, the staff made a focused effort to provide ADONIS training and documentation for users in the departments and outlying administrative areas.

ODRS coordinated a joint effort with the Alumni Association to provide timelier and more complete updates of alumni information by distributing data entry responsibilities to selected staff in Resource Development and accepting responsibility for several data integrity projects. Tracking changes in alumni business affiliations allowed the Office of the Chairman to send several hundred letters of congratulation.

Shelley Brown
Director

Office of Donor Partnerships and Special Projects

Building on MIT's history of support from non-alumni, the Office of Donor Partnerships and Special Projects, led by Christine Rinaldi, focuses on the identification, long-term cultivation, and solicitation of non-alumni capable of making eight-figure gifts in support of MIT priorities.

Donor Partnerships carries out its mission in close collaboration with other areas of Resource Development, the senior officers and deans, select faculty and other MIT officials, as well as volunteers. This partnership model was well exemplified in the $50 million commitment from the Picower Foundation, secured in December 2001 and announced in May 2002 to name the Picower Center for Learning and Memory. The office worked with the president, treasurer, dean of the School of Science, building architects, and the donors themselves while enlisting and coordinating the efforts of multiple people, offices and academic units, including the School of Science faculty, Capital Projects, the MIT News Office, and the offices of Communications and Donor Relations, Principal Gifts, Leadership Gifts, and Foundation Relations. More than 100 members of the MIT community and 16 members of the press attended the announcement that received national attention. The office maintained a special focus on funding for the brain and cognitive science facility, among other top priorities.

During FY2002, the office continued work with select members of the MIT Corporation and the Campaign Steering Committee. These volunteers were responsible for initiating more than a dozen new non-alumni prospect relationships. More than 35 faculty were involved in screening lists for potential new prospects. The president, senior officers, and key faculty continued intensive interaction with a growing core of top non-alumni prospects and donors.

Christine M. Rinaldi
Director

Office of Foundation Relations and School Development Services

Led by John Oldham, the Office of Foundation Relations and School Development Services develops and strengthens relationships with the foundation community while providing development services to the Institute's five schools. Gifts from private foundations and charitable trusts for this fiscal year totaled $64.2 million, up 48 percent from FY2001, and continued to provide significant support for The Campaign for MIT as well as MIT's educational and research programs.

Major grants or pledges included support of the MIT Center for International Studies, the MIT International Science and Technology Initiatives program, the Museum Loan Network, undergraduate biological sciences education, fellowships in the environment and in the Research Laboratory of Electronics, and biomedical research.

The Office of School Development Services (OSDS) provided prospect research support and project management for the fundraising efforts of the five schools, the Libraries, and the Office of Academic Development, and various school-affiliated centers and labs. In addition to other types of prospect research and project-related work, an increase in development travel by the deans and faculty resulted in the preparation of 241 prospect profiles, an increase of 21 percent from FY2001.

OSDS staff assisted in moving forward MIT's capital campaign priorities; one such example is the annual FYI Series, featuring a number of deans and faculty presenting information on Institute and school-based programmatic initiatives to educate the Resource Development staff. Other work focused on guiding school-based efforts centered on creating and funding new fellowship and lectureship funds and prospecting for both the bioengineering and the brain and cognitive sciences initiatives.

John E. Oldham
Director

Office of Gift Planning

Directed by Judith V. Sager, the mission of the Office of Gift Planning (OGP) is to allow donors to make life income gifts to MIT though MIT unitrusts, gift annuities, pooled income funds, and bequests. The OGP works with donors directly through its own marketing initiatives in addition to supporting the efforts of the front line development staff both in Resource Development and in the separate schools.

Gifts for FY2002 totaled $9.34 million. Two donors made gifts in the $1 million to $1.5 million range and three donors made gifts in the $500,000 to $1 million range, which accounted for 45 percent of all gifts received. Seventy-five donors made gifts ranging in size from $25,000 to $500,000.

This spring the OGP hosted informational estate planning seminars for prospective donors in San Francisco; New York City; Naples, FL; and Palm Beach, FL. OGP regularly provides its varied donor constituency with informative mailings highlighting the tax benefits of specific types of gift property and gift vehicles.

The Office of Gift Planning will continue to work closely with the Office of Campaign Giving, the Office of Principal Gifts, and the Alumni/ae Association to identify, cultivate, solicit, and steward planned gifts to expand the base of capital campaign donors.

Judith V. Sager
Director

Office of Principal Gifts

The Office of Principal Gifts (OPG) engages the Institute's most generous individual donors in the life of MIT, thanks them for their generosity, and encourages them to make additional multi-million dollar gifts. Under the leadership of Lucy Miller, OPG coordinates the efforts of the senior officers of the Institute and the campaign chairman to deepen relationships between current and future benefactors whose gifts undergird and transform MIT.

This year key accomplishments for OPG included leading the effort to secure additional naming gifts for construction of the Stata Center; working with the Office of the Corporation to plan the Zesiger Center and Simmons Hall dedications; and collaborating with the Office of Strategic Program Development to plan and support an intensive two-day cultivational campus program for gift prospects assigned to the Campaign Steering Committee (CSC). In collaboration with the Offices of Campaign Giving, Donor Partnerships and Special Projects, Foundation Relations, Leadership Gifts, and the development offices of the five schools of MIT, we increased from 193 to 202 the number of donors whose lifetime giving to MIT exceeds $1 million. During the fiscal year, the Institute received 20 new gift commitments of $1 million or more from individuals.

The work of the CSC continued to be a primary area of emphasis for the office. This year CSC members accepted cultivation and solicitation responsibility for 40 additional prospects, bringing their active assignment total to 139 at fiscal year's end. Total campaign commitments from CSC prospects increased by $37 million during the fiscal year, keeping the committee ahead of schedule to meet its internal goal of raising $75 million by the campaign's end.

Lucy V. Miller
Director

Vice President and Secretary of the Corporation

The vice president and secretary of the Corporation is responsible for relations and communications with internal and external constituencies and is the key interface between MIT's administration and trustees (the members of the MIT Corporation). The offices reporting to the vice president and secretary of the Corporation that comprise Public Relations Services—Conference Services, Events, and Information Center; the News Office; the Publishing Services Bureau; the Reference Publications Office; and Web Communications Services—work independently but collaboratively. The Office of the Secretary of the Corporation supports the work of the Corporation and its committees.

Public Relations Services

The offices within Public Relations Services (PRS) support the mission of the Institute by enhancing public understanding of MIT—and of higher education and research more generally—and by supporting the community life of the Institute through communications and special events.

Our memories of this year will always be defined by the terrorist attacks of September 11 and events in their wake both in the United States and overseas. The attacks demonstrated, tragically, the vital importance of mechanisms to inform and bring together the Institute community. The offices within PRS, especially the News Office and Web Communications Services (WCS), played essential roles in supporting the MIT community while also representing Institute activities to the outside world.

This year, the former Communications Office became the Reference Publications Office (RPO). Longtime director Barrie Gleason left the office to assume full-time responsibility for communications initiatives in the Graduate Student Office, to which she had already been a valued contributor. Stuart Kiang, a former managing editor at MIT's *Technology Review*, was appointed director; he will use his experience in scholarly publishing, electronic publishing, and information design to guide a comprehensive updating of the office's publishing technologies, together with a careful enhancement of publication design and content.

As noted in their respective reports, Publishing Services Bureau (PSB), RPO, and WCS continue to work effectively together. The many accomplishments of PSB design manager Timothy E. Blackburn were recognized with an Infinite Mile award for outstanding customer and client relations.

The vice president and secretary of the Corporation continues to convene monthly meetings of the Communications Operating Group and the Information Group, which offer ongoing opportunities for the exchange of ideas and information on issues regarding communications and public relations.

Margaret L. Berkovitz joined the staff of the vice president and secretary of the Corporation and soon established herself as an outstanding member of the team.

Kathryn A. Willmore
Vice President and Secretary of the Corporation

Conference Services, Events and Information Center

The mission of the center is to meet the information needs of the MIT community, visitors to the campus, and the public; to promote a sense of community within MIT; and to support conferences and events which enhance MIT's role in the broader academic community.

Events and Information Center

Serving as an information and welcome point for visitors, the Information Center is increasingly a central information source for members of the MIT community. The staff assisted faculty and administrative staff with the registration of 468 departmental events. Additionally, the staff implemented a training program for users of the online events calendar. Information Center staff also distributed over 45,000 pamphlets, brochures, maps, guides and catalogues; answered and redirected thousands of telephone and in-person inquiries; and served as a clearinghouse for mail addressed simply to MIT.

Terri Priest Nash trained 34 guides who conducted tours for 15,777 visitors, of whom 7,113 were prospective students, and 1,180 were international visitors. The tour guide captain was Christopher Toepel '02. Terri also arranged short-term visits that brought an additional 404 international guests to campus.

The director assisted with the logistics for the dedication of Gray House and the opening of the new graduate residence at 224 Albany Street. The staff also supported three Institute-wide memorial services—for Professors Michael L. Dertouzos and Kenneth L. Hale and alumnus Daniel M. Lewin (SM, 1998). Donald Ferland, assistant to the director, handled the arrangements for recruitment presentations by companies and other organizations that visit MIT under the auspices of the Office of Career Services and Preprofessional Advising.

Commencement activities began on Thursday, 6 June, with the hooding ceremony for 407 doctoral degree recipients. Chancellor Phillip L. Clay presided over this year's ceremony. The 136th Commencement exercises were held Friday, 7 June, and featured an address by World Bank group president James D. Wolfensohn before 2,187 degree candidates.

Conference Services

The Conference Services staff manages the logistical coordination and registration services for conferences and meetings sponsored by MIT faculty and staff. In 2002, the office coordinated 33 events that brought more than 10,000 conferees to campus. These events included the 14th International Symposium on Olefin Metathesis, the US/Germany Joint Meeting on Nanoscale Science and Engineering, the Center for International Studies 50th Anniversary Celebration, and the12th International Cryocooler Conference. The office once again offered logistical support to Campus Preview Weekend, the MIT Vendor Fair, the Senior Congressional Staff Seminar, and, in collaboration with the Industrial Liaison Program, the MIT Series on Technology and the Corporation.

Community Services

The Community Services Office (CSO) is responsible for enhancing the quality of life of MIT faculty and staff on campus, at Lincoln Lab, and at off-campus affiliate locations. The CSO supports the operations of MIT's Quarter Century Club (QCC), which includes over 3,000 members. Working closely with the QCC board and its president, Professor Anthony P. French, the staff coordinated five major events that were attended by more than 1,175 members and their guests. QCC also awarded four retirees educational grants through its William R. Dickson Retiree Education Fund.

The MIT Activities Committee (MITAC), with assistance and leadership from the Lincoln Laboratory co-convener, Karen D. Shaw, and the campus co-convener, Regina Dugan, responded to an increased demand for services resulting from successful efforts promoting MITAC to the MIT community. In 2002, nearly 26,000 members of the MIT community participated in MITAC-sponsored cultural and recreational events. MITAC organized 180 special events, for more than 7,300 participants, and sold over 18,600 discounted tickets for cultural and recreational events representing a 76 percent increase in ticket sales. MITAC gross revenue from ticket sales was $330,000 in 2002. MITAC highlights this year included trips to New York City to assist with Ground Zero volunteer efforts, well-attended noontime walks and lectures, and a campus construction tour.

The Association of MIT Retirees maintained paid membership of 700 retirees. A new initiative of regional lunches began this year to bring together colleagues for social gatherings. In addition to social activities, the association sponsored an investment seminar conducted by treasurer emeritus Glenn P. Strehle entitled "Living with Stocks in a Down Market" that attracted 60 attendees. During the year, members and guests enjoyed two one-day local trips and a four-day trip to Ottawa, Canada. The biennial membership directory was issued with the able assistance of Valerie Ristas, graduate student intern, and Satwik Seshasai, an MIT graduate student.

The CSO continues to take a leadership role in coordinating the MIT Community Giving Campaign along with a steering committee chaired by Professor Kenneth A. Smith. The office is actively involved in the selection and training of departmental solicitors; the campaign kick-off event; campaign communications; and processing donor pledges. The 2001 Community Giving Campaign raised over $400,000 from 1,200 employee donors.

The CSO also coordinated and promoted the Ford/MIT Nobel Laureate Lecture Series, welcoming John Hume, Nobel Peace Prize winner, to campus in fall 2001 and Dr. David Baltimore, Nobel Prize winner in physiology or medicine, to campus in spring 2002.

Personnel

Personnel changes included Traci Swartz joining the Community Services Office as administrative staff assistant.

Gayle M. Gallagher
Director

News Office

The MIT News Office is the Institute's central and coordinating public relations office. The mission of the News Office is to gather and provide clear information that promotes internally and externally the Institute's goals of advancing education, research, public service, and the public understanding of science and technology. It accomplishes this mission through internal communication, outreach to the news media, publications, and responding to the news media as the spokesperson for the Institute.

The watershed news events of the year, of course, were the attacks of September 11. The News Office and its web site played an important community role in the aftermath of the attacks. The News Office provided extensive coverage of teach-ins and other events related to September 11, and posted on the web a photo gallery of the community-wide event held September 12 on Killian Court.

This was also a banner year for recognition of MIT's extraordinary faculty, researchers, alumni/ae and programs:

—Eight people who have taught or studied at MIT were among the Nobel Prize winners in five fields in 2001, an unprecedented sweep of the Nobel awards by one institution's graduates and faculty. Professor Wolfgang Ketterle and two alumni, Eric A. Cornell (PhD, 1990) and Carl E. Weiman (Class of 1973), were awarded the Nobel Prize in physics. Other alumni receiving Nobels were Leland H. Hartwell (PhD, 1964), medicine and physiology; George A. Akerlof (PhD, 1966) and Joseph E. Stiglitz (PhD, 1966), economics; and United Nations secretary general Kofi Annan (SM, 1972), peace. Former professor K. Barry Sharpless shared the prize in chemistry.

—Tim Berners-Lee of the Laboratory for Computer Science, the inventor of the World Wide Web and maintainer of its operating standards as head of the World Wide Web Consortium, won the $400,000 Japan Prize.

—Professor of chemical engineering Robert S. Langer (PhD, 1974) was awarded the $500,000 Draper Prize for his innovative work in transmitting the right amount of medicine directly to the site of disease in the human body.

—Three MIT professors—Robert S. Langer, biologist Robert Horvitz (Class of 1968) of the McGovern Institute for Brain Research, and Elizabeth S. Spelke, professor of psychology—were recognized by *Time* magazine as being among "America's Best" in science and medicine.

—Professor Eric Lander, director of the Whitehead-MIT Center for Genome Research, announced in May that 96 percent of the mouse genome had been sequenced and had been deposited in a public database for scientists.

—Ann M. Graybiel (PhD, 1971), the Walter Rosenblith professor of neuroscience and an investigator in the McGovern Institute of Brain Research, was awarded the National Medal of Science for her research on brain regions implicated in the control of movement and cognition.

—The US Army selected MIT to be the site for the Institute of Soldier Nanotechnologies, a research institute that will design the clothing and equipment for the foot soldier of the future.

—*US News & World Report* ranked MIT's Engineering School as the best in the nation for the 14th year in a row. The *Financial Times* wrote favorably in a lengthy feature about the Cambridge-MIT Institute, the British government-sponsored program to increase research and education ties between two of the world's leading scientific universities.

—Michael J. Hawley (PhD, 1993) of the Media Lab gained wide media attention by winning the Van Cliburn competition for amateur pianists.

The News Office staff and a number of senior communicators at MIT participated in a seven-month strategic planning process, examining how to improve communications at MIT. The process included an analysis of strengths, weaknesses and opportunities in the current operation of the News Office; a survey of the MIT community regarding the ways in which they get their information about MIT; a survey of news offices at peer institutions to identify best practices; and interviews with major stakeholders and focus groups. The strategic planning team developed a set of recommendations for creating a more strategic approach to communications and enhancing the coordination of communications within the Institute, which will be pursued in the coming year.

Tech Talk published 34 issues in its 46th year of publication. The News Office also publishes Research Digest, a monthly two-page summary of the top research stories; MIT E-News, a monthly email and web newsletter summarizing the previous month's news, the current month's upcoming events, and significant news coverage MIT has received; and the MIT News web site at http://web.mit.edu/news.html. This web site summarizes and links to stories and photographs published by the News Office. In AY2002, the web site featured 533 stories, including 331 stories about the MIT community, 161 general news releases, and 41 news releases about September 11.

The News Office staff includes Denise Brehm, Darren Clarke, Donna Coveney, Myles Crowley, Lisa Damtoft, Patti Foley, Deborah Halber, Mary Anne Hansen, Patti Richards, Robert Sales, Elizabeth Thomson, Alice Waugh, and Sarah Wright.

Kenneth D. Campbell
Director

Publishing Services Bureau

The mission of the Publishing Services Bureau is to act as a coordinated channel for publishing activities across the Institute, applying the principles of strategic planning, technological awareness, supplier consolidation, vendor partnership, cost savings, excellence in design and editorial content, continuous learning, and customer satisfaction.

PSB coordinated over 1,000 jobs, assisting MIT publishers with publication planning and vendor selection, as well as advising on design, production, printing and web publishing. PSB continues its productive partnership with Web Communications Services, assisting MIT publishers in planning over 55 electronic publishing projects. Approximately $1.1 million was processed in print in fiscal year 2002, with an additional $3.4 million channeled directly to MIT/PSB preferred print partners; $1.2 million in creative services, of which $547,000 was for web site design, was managed through PSB.

Throughout the year, PSB worked with 19 preferred print partners, testing supplier consolidation assumptions and modeling best-practice behaviors. PSB and WCS have also developed partnerships with over 29 print and web design groups. The PSB procurement staff processed, facilitated, and advised on the issuance of purchase orders and contracts for $43.7 million in creative, print, and web services on behalf of MIT publishers.

Much of PSB's work is essentially collaborative in nature. The partnership with WCS provides "one-stop shopping" for MIT customers for coordinated print and web design and implementation. PSB continues to collaborate with WCS on the main MIT home page. MIT offices and departments continued to provide challenging opportunities to explore new technology solutions to meet

the more complex expectations of the online experience. In these endeavors, PSB and WCS collaborated with MIT offices including the Information Systems Usability team, the Information Technology Architecture Group (ITAG), the IT Delivery team, and Academic Media Production Services. In the year ahead, PSB and WCS will continue to evaluate opportunities for collaboration amongst MIT offices providing related services in order to ease the navigation of these services by MIT publishers.

PSB continued developing a graphic identity system for the Institute that will reflect MIT's mission and values as well as facilitate the operational handling of communications. This system will be implemented through incentives rather than mandates. In collaboration with type designer Matthew Carter, PSB design manager Tim Blackburn created several design concepts that were presented to various MIT constituents, including project sponsors Kathryn A. Willmore, John R. Curry, and William J. Mitchell, as well as the president and provost. The rich discussions led to the selection of a single design direction. Over the next several months, PSB will work with MIT publishers on the implementation of the new logo across their publications and will gather feedback regarding the use of the new logo. The feedback will assist in the development of an online and print style guide to inform MIT communicators and their design vendors of guidelines for use of the new logo, and will feature an area to access downloadable files of the logo. PSB continues to take on projects to test the design guidelines being developed; clients for this project have included the Reference Publications Office, the MIT Museum, and Resource Development.

In support of the new identity system, PSB investigated and made significant advances in the development of an online system that will allow stationery to be ordered through an electronic catalogue (ECAT). This will provide access to the new identity while providing a cost-effective and efficient way for MIT offices and departments to order business papers right from their desktop. Due to the significant advances in the electronic and print technology for such online systems, MIT is now poised to roll out this new system in the upcoming year. Using a web interface, the new ECAT stationery ordering system will provide offices with the choice of several business paper designs, including the recycled MIT bond, and will integrate with SAP.

Going forward, PSB remains committed to the promotion of strategic communications created using good publishing practices and will continue to evaluate and monitor partnerships with print, design, and creative vendors. Initiatives to promote community understanding include the development of a revised web site with additional tools for Institute publishers. PSB plans to develop an image archive, in partnership with the News Office and other Institute offices including the Archives, IS, and the Libraries.

PSB welcomed new media designer Victor Park in the summer of 2001, as well as senior support staff Ana Guevara. Print/design broker John Kramer left PSB in the spring of 2002. Promotions were awarded to Tom Pixton, electronic print broker, and to Minerva Tirado, procurement staff member.

Monica Lee
Director

More information about the Publishing Services Bureau can be found online at http://web.mit.edu/psb.

Reference Publications Office

The Reference Publications Office (formerly the Communications Office) works in concert with many offices across campus to provide members of the MIT community with accurate and authoritative information about the Institute's academic and administrative programs and policies.

This year was largely a time of transition. Outgoing director Barrie Gleason, who had been seconded to the Graduate Students Office at three-quarters time, became its full-time communications director in November. Communications assistant Diana Hughes completed her one-year stint in February, moving on to become a communications coordinator in the Human Resources Department.

The remaining office staff, consisting of publications manager Jennifer Fletcher and web publications manager Lori Weldon (whose promotion to that position became permanent), worked very effectively during the year to keep office publications on schedule and previously planned projects moving forward. General oversight during this period was provided by PSB director Monica Lee and WCS director Suzana Lisanti.

With their guidance, a planned web site redesign moved into the implementation phase, as did a project to rebuild the Filemaker database used to produce the Offices and Programs section of the MIT telephone directories. When completed, in July 2002, this project will initiate the office's transition to online content management, providing contributing offices across campus with an electronic interface for updating directory and catalogue information.

In addition, successful collaboration with colleagues in the Institute Archives resulted in new content guidelines for the Reports to the President that should help to make the reports more consistent in their approach and more useful as a cumulative history of the Institute.

In December, the office gained a new name—Reference Publications Office—intended to reflect more accurately its continuing mission to produce publications of record, as distinct from the general outreach function assumed

by the growing number of communications offices in MIT departments and programs. This name change also signaled the opening of a search for a new director, who was appointed in April.

Shortly after his arrival, a program to improve the readability of RPO publications began with a redesign of the online Reports to the President, beginning with the 2000-2001 edition. This effort will be extended to the print edition of the current reports, as well as to the print and electronic editions of the 2002-2003 telephone directories and course catalogue.

In these initiatives, RPO will actively consult with its partners PSB and WCS to ensure that its projects and goals remain aligned with the best practices and overall objectives of the Institute's Public Relations Services.

Stuart Kiang
Director

More information about the Reference Publications Office can be found on its new web site at http://web.mit.edu/referencepubs/.

Web Communications Services

Web Communications Services (WCS) maximizes the value of MIT web communications efforts by providing strategic consulting on web communications at MIT. WCS works closely with MIT clients and partners to support MIT's public relations, work processes, teaching, and research. WCS works to expand the depth and breadth of MIT's web-based services by researching and fostering new approaches to web-based communications.

Given the explosive and continuing growth in the use and impact of MIT's web pages, the current demand for web consulting continues to rise. Increasingly, our clients state that the web is integral to their work, and that it is rapidly emerging as the preeminent information medium. Approximately $2 million was purchased in web design services in fiscal year 2002. WCS advised on over 500 of these web projects.

WCS continues to partner with the Publishing Services Bureau to meet the web communications needs of MIT organizations and Institute-wide initiatives. Together, WCS and PSB provide seamless support for MIT customers in the area of communications planning and coordinated web and print projects. In the past year, WCS and PSB jointly consulted to and managed over 55 web design projects and developed partnerships with over 29 web and print design groups.

WCS publishes the official MIT web site at http://web.mit.edu, actively contributing to and supporting MIT's overall communications agenda. The MIT top level pages are viewed over one million times a month, providing entry to another one million pages of news, information and services. The home page aims to communicate the MIT identity within seconds, and to facilitate the process by which users find information about MIT and its achievements. Over the past year, WCS published two spotlights a day, with thought-provoking headlines and images that continue to receive praise from within and from outside MIT.

WCS assists MIT clients with projects at every stage with solutions ranging from planning to design, technical and business aspects of the web, production, troubleshooting and maintenance, as well as facilitating organizational change enabled by new technologies.

WCS engages in broad outreach and training efforts, organizing monthly meetings of the MIT Web Publishers group and providing additional classes on specialized topics. WCS also defines guidelines for effective use of the web at MIT, including usability, graphics, and accessibility guidelines. The WCS help desk answered approximately 5,000 email queries to the official MIT site this past year, contributing to MIT's public relations efforts. We answered an additional 2,000 help desk queries from the MIT community, helping clients manage their own web sites.

The WCS commitment to excellence has been recognized outside the Institute by the Council for the Advancement and Support of Education (CASE). WCS was selected to host the CASE New Media Awards 2002, a two-day event that brought 14 colleagues from peer institutions to MIT to judge and award medals to outstanding university web sites.

WCS continues to build relationships with Academic Media Production Services (AMPS) and the Academic Services Computing Team (ACST). The teams are working to understand each other's work and our combined services to faculty, and to improve communications to insure that faculty and other clients have a seamless and successful experience no matter which team is initially contacted. WCS continued to support the OpenCourseWare initiative, and contributed production expertise to the first courses to go online; WCS was instrumental in the web site and communications organization for the Cambridge-MIT Institute.

WCS collaborated closely with the News Office and senior officers in response to the tragic events of September 11, 2001, developing and maintaining web-based systems to keep the MIT community informed of MIT events. Several of the innovations developed during this time were later incorporated into MIT's web-based Emergency Preparedness Response System.

In the coming year, WCS will continue to enhance the quality of its services, of the MIT web site, and of its communication with the MIT community. Specific projects include rolling out a redesigned MIT home page; developing systems to facilitate more information exchange

and program development among communicators at MIT; and continued seamless collaboration with the PSB, the News Office, and AMPS in support of Institute web initiatives.

During 2001-2002, WCS welcomed new staff members Turi E. McKinley, Jeffrey L. Reed, and Margaret A. Wong, web consultants; and Susan F. Curran, web content editor. Timothy Griffin transitioned to the IS Help Desk. Christopher G. Sherrill moved to the position of team leader for web consulting, and Suzana Lisanti moved to the position of senior web strategist.

Suzana Lisanti
Director

More information about Web Communications Services can be found online at http://web.mit.edu/webhelp/.

Office of the Secretary of the Corporation

The secretary of the Corporation is one of the Institute's four corporate officers, with responsibility for administering the operations of the Corporation, MIT's board of trustees, including membership and standing committees, and, through the Office of the Secretary of the Corporation, quarterly meetings of the board, and 31 Corporation visiting committees that conduct biennial reviews of the Institute's academic and research programs. The secretary also serves as secretary of the Executive and Membership Committees, recording officer of the Corporation, and as joint signatory with the president in the awarding of academic degrees.

Corporation Meetings

Orientation Program and Annual Meeting

On October 4, 2001, an orientation program was held for new members of the Corporation. In the evening, new members and their spouses and guests were joined by members of the Executive, Membership, and Auditing Committees for a reception and dinner.

At the annual meeting on October 5, 2001, seven new members and four reelected members were introduced to the membership. The Corporation approved the action of the president in the awarding of September degrees, and, as part of the report of the Membership Committee, voted to approve the list of nominated members of the visiting committees. Reports were presented by the president, the treasurer, and the vice president of resource development and the chairman of the ongoing capital campaign. The members also heard reports from the chairs of the Auditing Committee and four visiting committees: Brain and Cognitive Sciences, Chemical Engineering, Libraries, and Political Science. Preceding the meeting, members gathered in the garden of the President's House for a group photograph. Following the meeting, members joined their guests at the Corporation luncheon.

December Meeting

At the meeting on December 7, 2001, the Corporation heard reports from the president and the chairs of the Membership Committee, the Corporation Joint Advisory Committee on Institute-Wide Affairs (CJAC), and visiting committees for Humanities, Nuclear Engineering, Sponsored Research, and Whitaker College. At the conclusion of the meeting, Corporation members and their guests attended a luncheon at the Faculty Club, where the Corporation recognized two Corporation members for two extraordinary gifts: to the MIT Libraries, the Siku Quan Shu, given by Marjorie M. T. Yang, and to the Institute Archives, the personal papers of Dr. Shirley M. Jackson, from her tenure as director of the Nuclear Regulatory Commission.

March Meeting

At the quarterly meeting on March 1, 2002, the Corporation approved the action of the president in the awarding of February degrees, and heard remarks on the transfer of George N. Hatsopoulos and Charles H. Spaulding to life member emeritus. Visiting committee reports were presented on the Media Laboratory/Media Arts and Sciences Section and on the Department of Urban Studies and Planning. The Corporation voted to accept resolutions on Professor Wolfgang Ketterle, MIT's newest Nobel laureate, who gave a short presentation on his research.

Reports were presented by the president, by the chairs of the Membership Committee, the Screening Committee, the Corporation Joint Advisory Committee on Institute-Wide Affairs, and by the president of the Alumnni/ae Association. The vice president for resource development, Barbara G. Stowe, and the chairman of the capital campaign, Raymond S. Stata, presented an update on the campaign's progress. Following the meeting, members of the Corporation and their accompanying spouses and guests attended a reception and luncheon at the Faculty Club, where they were joined by new and current MacVicar Faculty Fellows and members of the family of the late Professor Margaret A. MacVicar, for whom the fellowships are named.

Commencement Meeting

The final quarterly meeting of the academic year was held on June 7, 2002, prior to Commencement exercises, at which the speaker was James D. Wolfensohn, president of the World Bank. At the meeting, the Corporation approved the action of the president in the awarding of June degrees, and elected new members of the Corporation, members of the standing committees and committees of annual recurrence, chairs of the visiting committees, and members

of the Corporation Development Committee. The Corporation heard remarks on the transfer of Mary Frances Wagley to life member emeritus, and resolutions were read to honor four members completing their terms of service on the Corporation.

In addition, members heard reports from the president, and from the chairs of the Screening Committee and five visiting committees: Athletics, Physical Education, and Recreation; Linguistics and Philosophy; Materials Science and Engineering; the Dean for Student Life; and the Dean for Undergraduate Education. Corporation members participated in the academic procession to Killian Court for Commencement exercises, for which Edward O. Vetter served as Corporation marshal. A reception and luncheon followed for Corporation members and their guests, and officials and guests of the Commencement Committee.

Corporation Membership

Completed service effective June 30, 2002: Gregory K. Arenson, Osie V. Combs, Jr., Lissa A. Martinez, Elisabeth A. Stock.

Elected to a five-year term effective July 1, 2002: Mark R. Epstein, Paul J. Ferri, Jennifer A. Frank, Norman E. Gaut, L. Robert Johnson, Jorge E. Rodriguez, Alan G. Spoon, Susan E. Whitehead, Robert E. Wilhelm.

Elected for three years to fill an unexpired term effective July 1, 2002: James H. Simons.

Elected for a one-year term to fill an unexpired term effective July 1, 2002: Theresa M. Stone.

Elected life member effective July 1, 2002: Arthur Gelb, Ronald A. Kurtz.

Ex officio member for a one-year term effective July 1, 2002: James A. Lash, 2002-2003 president of the Association of Alumni and Alumnae of MIT.

Transferred to life member emeritus: George N. Hatsopoulos (January 2002), Charles H. Spaulding (March 2002), and Mary Frances Wagley (May 2002).

Corporation Committees

Advisory Committee on Shareholder Responsibility

The Advisory Committee on Shareholder Responsibility did not meet as a group in 2001-2002. The treasurer monitors votes in accordance with guidelines previously established by the committee and is charged with convening the committee if new issues arise during the year.

Auditing Committee

Meetings of the Auditing Committee were held on October 4, 2001; February 28, 2002; and June 6, 2002. In attendance were the Auditing Committee members, representatives from PricewaterhouseCoopers, personnel from the MIT Audit Division, various MIT financial staff members, and invited members of the MIT administration.

The October meeting included a report from Allan S. Bufferd, MIT treasurer, on the fiscal year 2001 financial statements and the Institute's gifts and investments. John Mattie of PricewaterhouseCoopers presented their report, which contained an unqualified opinion, comments addressing control issues in the MIT Press, and updates on the Institute's risk management and capital construction initiatives. Deborah L. Fisher, the Institute auditor, reported on internal and external audit activities. The committee unanimously approved adoption of a MIT Auditing Committee Charter and approved management's recommendation to appoint the firm of PricewaterhouseCoopers as auditors for fiscal year 2002.

The February meeting included opening remarks by President Vest requesting the committee to remain vigilant, particularly in the post-Enron environment. Ms. Fisher presented the audit plan for 2002, noting the division was fully staffed. A report on quarterly financial results for the second fiscal quarter was provided and reviewed. This included an update of the financial condition of the Media Laboratory, and discussion of the current joint audit review of PricewaterhouseCoopers and the Audit Division. Julie T. Norris, director of sponsored programs, and Jamie Lewis Keith, director for environmental programs and risk management and senior counsel, presented recent developments subsequent to the terrorist attacks of September 11, including the new USA Patriot Act, which restricts certain activities by certain individuals involved in research.

The June meeting included a presentation by Ms. Fisher of a new Audit Committee Minutes Tracking Report, which will ensure the committee's requests are adequately and timely responded to by management. Mr. Mattie and Ms. Fisher presented the preliminary results of the review of the Media Lab's financial condition and the committee discussed with management and the auditors the status of corrective actions. The financial results for the third quarter were presented by Controller James L. Morgan. The committee also received several reports on matters raised at previous meetings, including the status of how certain service costs are recovered, the current and future deployment of the SAP management information system, and a summary of international initiatives. The committee reviewed a draft policy on the use of the Institute's independent accounting firm for non-audit services.

Corporation Joint Advisory Committee on Institute-wide Affairs

The Corporation Joint Advisory Committee on Institute-wide Affairs (CJAC) held meetings during the year in conjunction with the quarterly meetings of the Corporation in October, December, and March. A special meeting was

also held in January 2002. Discussions focused on the need for improved communication between decision-makers and the major constituent segments of the MIT community, including undergraduate and graduate students, faculty, alumni/ae, and staff. Dinners to bring Corporation members together with students and faculty for informal conversation followed each of the CJAC meetings. The October meeting, held jointly with the Screening Committee, also focused on the process of nomination and election to the Corporation. The chair of CJAC, Linda C. Sharpe, presented reports of the committee's activities to the Corporation at the December and March meetings.

Corporation Development Committee

Activities of the Corporation Development Committee are covered in the annual report of the vice president for resource development, under the Office of Individual Giving.

Executive Committee

The Executive Committee met ten times during the academic year 2001-2002. The committee continued to devote substantial time to management issues including long-range planning, resource development, financial operations, and capital projects. Other topics of discussion included the impact on MIT specifically and higher education and research generally of the events of September 11; government-university relations; innovative programs of teaching and research; and initiatives in student life and learning.

Investment Committee

The Investment Committee held three regularly scheduled meetings during the 2001-2002 academic year under the leadership of Michael M. Koerner, a member of the committee for many years who was named to the position of chairperson effective July 1, 2001.

The Wellington Management Company of Boston remained the primary investment manager and advisor for publicly traded securities, both domestic and international, an appointment that they have held for more than twenty years. The Institute continued its program, managed by three other investment management firms, of equity investments in smaller capitalization companies and through four other investment management firms of investments in international equities. The program for domestic and international alternative investments to publicly traded securities was further expanded during the past year, especially in hedge strategies. In addition, the Institute increased its investments in real estate, especially in commercial properties in the Cambridge area. The alternative investments are managed primarily through pooled investment funds by a diverse group of managers. These investments include the areas of private equity, non-Cambridge real estate, arbitrage, and distressed debt.

Membership Committee

The Membership Committee held three meetings during the academic year to discuss matters concerning membership on the Corporation, and to nominate new members of the Corporation and of various Corporation standing committees and committees of annual recurrence.

Corporation Screening Committee for Nomination of Recent Graduates

The Screening Committee for Nomination of Recent Graduates, in collaboration with CJAC, held a joint dinner meeting for students on October 4, 2001, in part to explain the nomination and election process for membership on the Corporation. The committee met via two teleconferences, in January and February 2002, to review all nominee applications. From a group of 43 candidates, the committee selected six for the ballot. The nomination process was conducted under the auspices of the Alumni Association using an electronic ballot over the internet. Ms. Jennifer A. Frank '00 received the nomination and was elected in June to serve a five-year term on the Corporation.

Corporation Visiting Committees

Sixteen Corporation visiting committees convened for regular two-day meetings during the academic year 2001-02: Athletics, Physical Education, and Recreation; Biological Engineering; Earth, Atmospheric, and Planetary Sciences; Humanities; Linguistics and Philosophy; Materials Science and Engineering; Mathematics; Mechanical Engineering; Media Laboratory/Media Arts and Sciences, Nuclear Engineering; Sloan School of Management; Sponsored Research; Dean for Student Life; Dean for Undergraduate Education; Urban Studies and Planning; and Whitaker College.

In 2001-2002, the Institute's 31 visiting committees were composed of 416 persons filling 537 membership positions: 61 Corporation members filled 159 slots; 194 presidential nominees filled 202 slots; 170 alumni nominees filled 176 slots. Nine people filled both a presidential nominee slot and an alumni nominee slot. Of these nine, two also each filled one additional alumni slot.

Women made up 21 percent of the visiting committee membership, and minorities 17 percent. Thirty-five percent of the members were affiliated with academia, 54 percent with business and industry, six percent with government and law, and five percent with other organizations, including nonprofit enterprises.

Office Activities and Personnel

Under the direction of Susan A. Lester, associate secretary of the Corporation, the staff of the Corporation Office managed the quarterly meetings of the Corporation and 16 visiting committee meetings, in addition to overseeing the annual renewal of committee memberships and

producing such publications as the visiting committee roster and the Corporation picture directory.

Special mention should be made of the flexibility of the staff of the Corporation Office in accommodating changes in the visiting committee calendar as a result of the tumultuous and tragic events of September 11. Moving one meeting from the fall of 2001 to the spring of 2002 resulted in an unprecedented eleven meetings during the spring term, all of which were carried out with cooperation and good will between the Corporation Office and each of the departments visited. Melanie McCue's efforts in this regard were particularly noteworthy.

Michelle D. Hinkle continued her competent and efficient service to the members of the Corporation, and we all benefited from the energy, interest and enthusiasm of our student helper, Basilia Huang, who graduated from MIT, and the Corporation Office, in June.

Susan A. Lester
Associate Secretary of the Corporation

More information about the MIT Corporation can be found online at http://web.mit.edu/corporation/.

Treasurer of the Corporation

In FY2002, revenues and funds of $1,592.7 million were used for operations. Total operating expenses were $1,535.9 million. The results of operations were $56.8 million in FY2002 in comparison to $38.3 million in the prior year.

Total net assets on June 30, 2002, were $7,082.2 million, a decrease from the $7,855.9 million reported as of June 30, 2001. This decrease was substantially the result of the market value of the investments.

In addition to the management of the investment program, the Office of the Treasurer provided assistance to the Institute's overall financial operations and planning in conjunction with the Office of the Executive Vice President.

Other activities of the Office of the Treasurer supported Institute real estate planning, community relations, and the Office of Resource Development.

Allan Bufferd
Treasurer of the Corporation

For more information on the Treasurer's Office, see the Report of the Treasurer at http://web.mit.edu/cao/www/reports/TR2002.pdf.

Association of Alumni and Alumnae of MIT

Four vectors define the past year for the Alumni Association (AA), our programs and services, and our relationship with MIT and its 100,000 alumni.

The Institute's alumni community was not exempt from the tremendous shock shared by all in the wake of the terrorist attacks of September 11, an event that continues to reverberate a year later. Eight alumni died in the attacks on the World Trade Towers and the Pentagon. The Association has tried to understand the implications of September 11 on our programs over the course of this year.

While sorting out the long-term impact of September 11 on the Alumni Association and our constituency, we also spent the past year working our way through a top-level organizational change and a series of moves into new office spaces on campus.

These changes, along with events on campus, have necessitated a closer examination of the way we communicate and interact internally within the AA and on campus, and externally with our alumni. During the year we have improved and evolved our communications practices. We are using the web and email in new and more effective ways to connect alumni with the Institute and each other.

The fourth vector defining this year is a growing awareness of the importance of alumni as a resource for MIT. From its earliest days MIT has depended on alumni as financial supporters of the Institute. Over the last century, thousands of alumni volunteers have been involved in the governance of the Institute as well as in running programs that connect alumni with the Institute, and alumni with alumni. Due to changes in technology, MIT can now use alumni volunteers in novel ways in the life of the Institute.

Like all Americans and people around the world, the MIT alumni community was shocked by the tragic events of September 11. On September 21, 2001, just 10 days after the terrorist attacks, we hosted the annual Alumni Leadership Conference (ALC). With reports of "credible evidence" of even more terror attacks being reported in the local and national media, more than 340 alumni volunteers and guests from across the United States and the world persisted and returned to campus September 21 and 22 to celebrate their achievements, reconnect with campus life and refresh their volunteer skills. The fact that all those people chose to return to Cambridge—when travelers everywhere were canceling flights and avoiding large cities—reinforced for me that, in times of stress and uncertainty, people share a profound need to seek out the common bonds that hold us together. During that weekend, in a time of tragedy, the Association provided a link for our alumni leaders to people who shared their educational background and interests, and a commitment to a global community.

In the wake of these events, the ALC, with its notable attendance, was a remarkable outcome that was replicated several times over the course of the last year. Many of our regional events were oversubscribed, as rooms hosting events such as the Young Alumni Seminar in New York City overflowed with alumni looking to connect with each other and the Institute. In June, we enjoyed a five-year high in attendance at Tech Reunions 2002 as almost 2,800 alumni and their guests returned to Cambridge to renew old acquaintances, make new friends and celebrate all things MIT.

The Association and its alumni were saddened by the deaths of eight of our own on September 11: David M. Berray, SM '00, Charles E. Jones, SM '80, Frederick Kuo, SM '70, Daniel M. Lewin, SM '98, Michael B. Packer '80, Donald A. Peterson '57, Thomas F. Theurkauf '79, and John J. Wenckus '77. In the immediate aftermath of the terrorist attacks the Association established an *Are You OK?* electronic bulletin board on our web site. Alumni—especially those who lived and worked in New York City and Washington, DC—visited the site to check in on their fellow alumni who had been listed as missing, to review the updated list of deceased alumni or just to share their reflections in the wake of these tragedies.

This past year was marked by a major organizational change for the Association with the appointment on October 1, 2001, of Elizabeth A. Garvin HM as managing director of the Association. By making Garvin my principal deputy, managing internal operations, my time has been freed to work on building more connections with our alumni and thinking about the future of the Association. As Garvin assumed this new role, many senior staff relationships had to change. The staff and I have devoted a great deal of energy to making these relationships work for MIT and its alumni.

In December, a significant portion of our staff moved into the renovated space in Building W59 that had been occupied by *Technology Review*. With personnel now scattered across three buildings on campus (10, W59 and W92), we have worked hard to bridge the gaps in communication that such a situation can create. Our staff has done a remarkable job in staying connected, rotating meetings to our three locations and making extra efforts to communicate with their colleagues.

The effects of September 11 and our internal changes, taken together with changes at MIT, have emphasized the importance of our communications, both internal and external. As we evolve the way we talk with and listen to alumni and staff, we are focusing on better use of the electronic resources—email and the web—at our disposal. In the winter of 2000–2001, we hired three communications specialists, creating a Communications

Convergence Team to coordinate our efforts and ensure we stay "on message" when we reach out to our alumni. This effort yielded a wonderful variety of new projects in FY2002, including the October 2001 launch of the eAVC (Electronic Alumni Volunteer Connection) newsletter that is sent out to approximately 4,500 alumni volunteers each month; a new and improved Alumni Volunteer Connection news section of *Technology Review*; the creation, with Resource Development, of the award-winning *Giving to MIT* web site; and most notably, the launch in May 2002 of the monthly Tech Connection newsletter that is emailed to all 61,000 alumni for whom we have reliable addresses. Other Association communications receiving award recognition this year included *openDOOR*, our online magazine, and the young alumni campaign solicitation plan.

As we have improved and integrated our email and print communications, more of our alumni have discovered the convenience of signing up for our events and services online. In January 2002, we celebrated the registration of the 40,000th MIT alumnus for the Infinite Connection, the Association's suite of online services for alumni. Email Forwarding For Life now sends more than three million messages each month for a total number of 33,477,784 email messages forwarded in FY2002. Overall participation in the Infinite Connection approaches 50 percent of all MIT alumni.

L. Robert Johnson '63, the president of the Alumni Association this year, using the talents of MIT Video Productions, created a compelling presentation that showed the best and most current MIT research and news. This presentation provided a much-appreciated glimpse of the Institute's vitality to alumni who saw it around the country when Johnson visited their areas. It can now be viewed online by alumni and other visitors to the Association's web site at http://web.mit.edu/alum/.

The financial support from individual alumni that has helped to make this institution strong throughout MIT's history continues to the present. In this most challenging of years in the world economy, the Alumni Fund produced remarkably strong results in financial support from our graduates. Our alumni proved once again that they are a substantial financial resource for the Institute with gifts from 28,626 alumni, 1,900 parents, and 503 matching gift companies combining in an alumni fund of $30.02 million. This exceeded the fiscal year goal of $30 million. These results represent a remarkable outcome in a troubled year, and serve as a testament to the continued investment of MIT alumni in this special place.

Alumni volunteers have always been integral to governance and policy at MIT. Hundreds of alumni served the Institute this year, including the 15 term members of the Corporation nominated by the Association's national selection committee and the six alumni nominees who served on each of the Corporation's 31 visiting committees.

More than 5,000 alumni gave their time and commitment to MIT through such important tasks as recruiting students, connecting their fellow alumni with the Institute and fund raising. They are our ambassadors to the world, telling MIT's story and working on the Institute's behalf.

There is also at MIT a long history and tradition of using alumni as resources in the classroom—as project mentors, as instructors in some instances, or as field advisors on theses. Because of the technology available today, it is now possible to reach beyond the handful of former students who have been involved in these ways. Opportunities for engagement with students and faculty can be extended potentially to anyone connected to the Internet. I believe the impact of this potential is going to be startling. The MIT Council on Educational Technology, encouraged by alumnus member Hal Abelson, PhD '73, has established a mechanism by which the dean for undergraduate education and the Alumni Association are encouraging faculty to experiment with this approach.

This year alumni have worked with faculty on projects such as Mission 2005, a subject which engaged alumni with students to solve the problems of undersea exploration; with students in the new Undergraduate Practice Opportunities Program instituted by the School of Engineering; through the Association's Externship Program; or by participating in Independent Activities Period seminars. Over the course of the last 18 months, we have a record of nearly 400 alumni who participated in these programs, sharing their life experiences with students in a way that benefits both the alumni and the students.

This report documents Alumni Association activities this past year along the three themes for our work during the year: connect, participate, explore. Last year, in attending our events, in serving the Institute as volunteers and in supporting MIT financially, alumni heeded our call to connect with the Institute, the Alumni Association and each other; to participate in the Alumni Fund, in our events, and in their class and regional clubs; and to explore the opportunities for engagement and lifelong learning we offer through our activities both on campus and off. I continue to be impressed by the depth and breadth of the varied expertise that our alumni body and its leaders bring to the Association and the Institute.

Connect

We offered our alumni, students, and parents a number of different ways to connect with the Institute and each other over the course of the last year. From Tech Reunions 2002 to *Technology Review*, from our MIT regional clubs to Family Weekend, this wide variety of programs offers people an opportunity to experience the richness of the Institute's research and learning environment; develops loyalty among alumni through a lifetime of potential connections to the Institute; and offers parents a glimpse of their child's experience as an MIT student.

Tech Reunions 2002 and Technology Day

Each June, Tech Reunions serve as the centerpiece of the Association's relational program, and this year, we celebrated a five-year high in attendance. Total attendance (alumni and their guests) over the weekend of June 6–9 was 2,790, a 10 percent increase in attendance from June 2001. Several reunions marked a five-year high in attendance. The Class of 1997 had 213 members attend Tech Reunions, a 39 percent increase over the five-year average for the fifth reunion; the 20th reunion of the class of 1982 had 252 attendees, a remarkable 51 percent increase over the five-year average attendance of 167 people; and the class of 1967 saw a 36 percent increase in 35th reunion attendance, as 172 people came to celebrate.

Alumni participated in a number of class-specific events on Friday, June 7, including dinners at the New England Aquarium and events at the Gray House, and gathered on Saturday night, June 8 for the popular Great Court Gala. More than 750 alumni and their guests danced under a tent in Killian Court, while others gathered in the Bush Room "piano bar." Saturday's events began with the annual Memorial Service, made more poignant this year with the loss of the eight alumni on September 11, and a reception held to thank reunion committee volunteers.

On Saturday, June 9, the Technology Day symposium *When Worlds Collide: Science, Politics and Power in the 21st Century* focused on the impact of science outside the lab. The morning session considered several critical questions: How do scientists and politicians negotiate the complex issues where science and politics collide? What changes can we anticipate in how budding scientists are educated—from grade school through graduate school? At a time when the pace of scientific discovery and its influence on society are increasing, it is more important than ever to stop and take stock of how scientists exert influence as educators, thought leaders and policy makers. A diverse set of three afternoon panels focused on topics related to the overall theme.

Technology Day morning panelists included Ronald G. Prinn, ScD '71, the MIT TEPCO professor of atmospheric chemistry and head of the Department of Earth, Atmospheric and Planetary Sciences; Shirley M. Malcom, P '01, director of the Directorate for Education and Human Resources Programs of the American Association for the Advancement of Science; Daniel Charles, an author and contributing science correspondent to National Public Radio, and a former Knight science journalism fellow at MIT; and John M. Deutch '61, PhD '66, an Institute professor in chemistry who has served in the past as director of the CIA, deputy director of Defense, and undersecretary of the US Department of Energy. This program has been posted on MIT World, with the exception of Professor Deutch's talk.

Despite a rainy start to the reunion weekend, the weather cleared by Sunday when we hosted the annual Reunion Row and the Tech Challenge Games. Seven teams representing the classes of 1997, 1992, 1982, 1977, 1972, 1962, and 1952 returned to the Charles River to compete in eight-person shells. The class of 1992 took the Reunion Row, an event which was marked by the dedication of a new crew shell in honor of the Alumni Association's own Stuart Schmill '86, the director of the Parents and Students Program for the Association and a former MIT crew coach. At the Tech Challenge Games the class of 1982 triumphed, topping rival classes in such events as the Hexagonal Close Packing competition and the Tuition Riot. The whole weekend ended with a family barbecue in Steinbrenner Stadium.

Innovations to Tech Reunions 2002 included changes to Camp Tech, the program we offer to children of alumni returning for their reunion. This year, the Alumni Association worked in partnership with departments around campus to offer participating children a "drink from the fire hose." Almost every Camp Tech program had an MIT departmental focus, as well as a teaching element, and alumni responded positively to the change of programming with Camp Tech seeing its highest enrollment in years (56 children). The class of 1962 also initiated a new tradition for the 40th reunion: a gray vest with class crest to start building their Tech reunions wardrobe, to complement the red jacket they will receive at their 50th reunion.

Young Alumni and Students

In December 2000, the MIT Alumni Association began an effort to increase financial and programmatic participation among its young alumni population (undergraduate alumni from the last 10 graduating classes). The Association commissioned a comprehensive email and web-based survey of this constituency. This data was supplemented through a series of nationwide focus groups. These findings have shaped the messages, communications, and tone of our programs with students and young alumni.

A relations program for young alumni was revitalized in 2001–2002, with the hiring of Laura L. DePaoli '97, a new Student and Young Alumni Programs staff member, in October 2001. The Young Alumni Seminar Series was launched with events in Washington, DC, New York City, and Boston. The 295 total young alumni who attended these events provided very positive feedback that will help us as we plan more seminars in FY2003.

A key element of our focus on young alumni is more engagement with students—our future young alumni constituents. The year was spent in strategic review, and five student focus groups were at the center of this review. A plan is being put in place for execution in FY2003, the main tenet of which will be finding ways to best form an early and lasting relationship with the students.

Ongoing programs include work with the student living groups and the Association of Independent Living Groups, an alumni group. We assisted several living groups with fund-raising programs, including Theta Xi, Sigma Chi, Chi Phi, and Burton-Conner. We had a record 13 applicants for the D. Reid Weedon Jr. '41 Alumni Relations Award, indicating that awareness of the importance of alumni involvement is growing in the independent living groups. We handled a record 90 requests from student groups for database information, more than double the volume of two years ago. Thirty-four student ambassadors participated in 42 events for a total of 195 Ambassador placements.

To introduce graduating students to the opportunities MIT makes available to alumni, Association staff developed and promoted a web site called You Made It. This site replaced the annual Alumni Activities Expo in Lobby 10. The cost-effective site and marketing efforts were very successful, with 86 percent of graduating seniors signing up for the Infinite Connection and 65 percent of departing graduate students.

Alumni Communications

In winter of 2000–2001, with the hiring of Eve Downing, Jon Paul Potts, and Andrew Skola, the Association committed itself to forging a more systematic and comprehensive communications plan. These three Association staffers worked together on the Communications Convergence Team to coordinate our communications efforts in support of The Campaign for MIT, the Alumni Fund and all alumni programs and services.

This year the most dramatic example of our ability to respond quickly and use technology effectively in communications was the *Are You Okay*? web bulletin board launched on September 15, 2001, four days after the terrorist attacks on the World Trade Center and Pentagon. Alumni were desperate to find out whether classmates living or working in the affected areas were safe, and this bulletin board served as a public forum, not only for alumni to let others know they had survived, but to relate their first-hand experiences of the events. Because the board garnered more than 1,000 messages in a two-week period, the names of those posting were cross-referenced alphabetically and by class year to make it easier to find a particular person. Later, as the identities of the confirmed eight alumni victims were discovered, their names and obituaries were also posted on the Alumni Association web site. The quick actions of the Alumni Association in developing and maintaining the *Are You Okay*? board helped bring the alumni community together in a time of unprecedented crisis. We also emailed and mailed a message to all of our alumni from MIT president Charles M. Vest HM, addressing the events of September 11 and letting alumni know what was happening at the Institute to help the campus cope with the aftermath of the terrorist attacks.

Technology Review, now an independent MIT enterprise, is the only communication piece that all of our alumni receive monthly. Four pages in *Technology Review*, the Alumni Volunteer Connection (AVC) pages, are dedicated specifically to recognizing our volunteers and marketing Association programs. Communications vehicles new this year are two email newsletters that are sent out each month to different constituencies, complementing and often augmenting the content in *Technology Review*.

The eAVC newsletter is emailed to approximately 4,500 alumni volunteers each month, containing hot links to content on the Association web site about volunteering, MIT news, and Association programs and services. This communication also features sections targeted specifically to class and club leaders.

The Tech Connection, an email newsletter that we send out to the 61,000 alumni for whom we have reliable email addresses, contains current news about MIT and reminders of the products and services available from the Alumni Association. The guiding principles for Tech Connection content are timeliness, interest value for alumni and marketing value for the Association. Its primary function is to drive readers to the web, both the Association site and other MIT sites of interest. The first issue sent in May 2002 was mailed by MIT Information Services. Subsequent issues of Tech Connection have been handled by an outsourced provider of precision email marketing services, enabling us to track who is reading the newsletter and what links are attracting the most online traffic.

Through our comprehensive web site at http://web.mit.edu/alum/, we continue to offer our alumni compelling online content, including *openDOOR*, and *What Matters*, a guest opinion column written by a different MIT alumnus each month. The columns received more than 14,000 hits last year.

Infinite Connection services have continued to be very popular with alumni: more than 45,700 alumni are currently registered, more than 2,000 have volunteered as online career advisors, and alumni have created more than 226 mailing lists on subjects ranging from entrepreneurship to golf. Alumni are actively looking to connect with one another. They have conducted 128,000 searches in the online directory. We now host 57 class web sites and 42 club web sites. The Infinite Connection advertising campaign won a silver medal in the 2002 CASE Circle of Excellence Awards. The campaign was instrumental in helping us reach our FY2002 goal of 45,000 users. Our very first online service, Email Forwarding for Life, remains popular as we forward 3 million messages monthly for the 50 percent of our alumni who have registered for this service.

In April, the Alumni Association expanded the campus community's participation in the Infinite Connection by offering students access to the system. In April 2002,

current MIT students—both graduate and undergraduate—became eligible for accounts that include access to the Online Alumni Directory (OAD) and ICAN. The increased contact between students and alumni is expected to have significant benefits for both communities, and alumni have been encouraged to edit their personal listings in the OAD to include a photo and a message indicating that they welcome student contact.

This year, we completely overhauled our Tech Reunions marketing plan. We increased the amount of email marketing, including targeted emails from the class officers, from Hollie K. Schmidt '87, the Technology Day chair, and from myself. This new approach seemed to work as 65 percent of our registrations came in via the Alumni Association's web site, an increase on the 41 percent for Tech Reunions 2001. We also completely redesigned all of the print collateral and revised our messages so they were targeted more to our specific class constituencies. These efforts contributed to the high attendance numbers at this year's events.

Alumni Career Services

We have continued to augment our career-related services, connecting alumni mentors to young alumni and students, and potential alumni employees with alumni employers. In November 2001, a career services survey was sent to undergraduates with degrees in the last 15 years and graduate-degree holders five years out. The survey, which yielded a 21 percent response rate, reiterated themes uncovered in the Young Alumni survey: current career services are largely unknown or underused by alumni, networking and online services are top priorities for alumni, and alumni are largely unwilling to pay for career services. We continue to evaluate the scope of our career services in light of these findings.

We completed online enhancements of the Institute Career Assistance Network (ICAN) program with the second version launch in late March 2002. With these enhancements, we are now able to track usage data to evaluate the service. During the spring, 40 percent of the current advisors updated their profiles following a series of email messages, postal letters, and phone calls. We have recruited additional career advisors and users, instituted email messages, and developed new marketing materials. Current advisor numbers stand at 2,356, an increase of six percent over FY2001.

The following testimonial from Shelley M. Cazares '98 indicates how the program touched a recent graduate: "I am currently living abroad and searching for a job back in the USA. The long-distance element is making my job search very hard. I've applied to about a hundred positions and have been turned down or ignored. The online mentoring system has been the only positive lead I've had. Furthermore, it has led me directly to job interviews. I don't know where I would be without it."

In addition to ICAN, our online career services include an alum-to-alum job bulletin board, a free service maintained by the Association and monitored daily by our staff that posted more than 800 jobs this year. The Association was a founder of ePronet, an online recruiting service. This service had a challenging year, during which the company was sold to Experience Inc. of Boston and alumni usage declined. In the coming year we hope to increase alumni satisfaction with and usage of this product as we work closely with Experience Inc. on enhancements of content and a potential login synchronization with the Association's Infinite Connection.

Regional Activities

FY2002 was a challenging yet successful year for our 91 alumni clubs. The events of September 11 had a significant impact on individual club success. Some clubs that had launched their fall 2001 programming early in September were sustained through the tragedy, and even found that events in the weeks immediately following were well attended by alumni who wanted to renew bonds with their fellow club members. But those clubs that had started later—after September 11—found their annual membership campaigns and event mailings pushed back even further into the fall and winter as the world struggled to come to terms with the crisis. Membership numbers for this fiscal year are down from previous years, with some major markets such as New York and Southern California exhibiting significant dips in membership. The MIT Club of New York decided not to send out a stand-alone membership appeal in the fall. One had been planned for September, but the club board agreed that it would not be appropriate after September 11, and membership numbers understandably dropped.

Event highlights this year included the 75th anniversary of the MIT Club of South Texas; the MIT Club of Boston Gala honoring Harvard President Lawrence M. Summers '75; and the six events featuring President Vest as speaker, held in Singapore, Japan, Switzerland, Great Britain, Puget Sound, and Southwest Florida. Chancellor Phillip L. Clay, PhD '75, met with alumni clubs in Martha's Vineyard, Atlanta, Houston, and Delaware Valley.

Graduate Alumni

As MIT's graduate student population continues to grow, half the alumni body will soon be made up of people whose first degree from MIT is at the graduate level. This trend has been obvious for more than 15 years and the Association has devoted attention to serving and involving these alumni, mostly through department-specific programming that continued this year. This year we initiated two regional activities designed with this constituency in mind. Working with key alumni in three corporations, we hosted events in Silicon Valley at Sun Microsystems, in Boston at Fidelity, and in Cambridge at

MIT, the single largest employer of MIT alumni in the Boston area. In Washington, DC, Dean Isaac M. Colbert spoke to 125 attendees at the first regional event specifically for graduate alumni.

The Association organized a series of five graduate student focus groups that brought 50 graduate students together to discuss their views and share their opinions of MIT and the Alumni Association in order to identify areas where the Association can make an impact on graduate students. These focus groups complemented an online survey of graduate alumni to which 2,200 graduate school-only alumni responded. Data from this research have led to consideration of programmatic options to foster more engagement with our graduate school-exclusive alumni.

Parents Association

The Parents Association activities this year included Family Weekend, parents' publications, the Parents Fund, and the Parent Connector Program.

Family Weekend in October 2001 saw a record 577 families, with a total attendance of 1,840 people. The event-packed weekend offered parents the opportunity to attend classes, tour MIT laboratories, attend lectures given by MIT faculty, and listen to performances by many MIT student groups. The weekend's keynote address, "The Human Genome and Beyond," was given by Professor Eric S. Lander, founder and director of the Whitehead Institute Center for Genome Research. The annual Nobel Laureate luncheon on Friday featured professor emeritus Robert M. Solow HM, winner of the Nobel Prize for economics, who led a discussion on the effects that the events of September 11 may have on the economy.

The Parents Association hosted regional parent events in four cities: New York City with President Vest; Houston with Chancellor Clay; Northern California with Alexander V. d'Arbeloff '49, chairman of the MIT Corporation; and Boston with Robert P. Redwine, dean for undergraduate education. In all, the regional events touched 142 participants, nearly double the attendance of the prior year. We also increased Association staff involvement with Parents Orientation and Campus Preview Weekend.

Communications with parents were strong this year, resulting in record participation in the Parents Fund. Through our Parent Connector program, 234 families made 165 welcome calls and hosted 10 send-off events. The year began with a new communication piece, a summer mailing to all incoming freshman parents with a cover letter from President Vest and a guidebook to the services of the Parents Association. We also issued three editions of Parents News, up from two in previous years.

Other Alumni Groups and Activities

Fiscal year 2001–2002 saw the firming of the partnership between the Alumni Association and the Department of Athletics, Physical Education, and Recreation. New initiatives this year included a download of varsity athlete data which generated approximately 3,000 new sport records; the creation of club sport codes in the Advance database that resulted in the addition of more than 1,000 records; and arranging for the director of athletics to speak to various audiences, including the Alumni Fund Board, Parent Volunteers, and the MIT Club of Boston.

The Chinese Alumni of MIT (CAMIT) affinity group, under a new president's leadership, Greer T. Swiston '87, increased activity and communication among its chapters. CAMIT held its annual Chinese New Year Banquet in Washington, DC, working with the local MIT regional club to publicize it. The Arab Alumni Association sponsored the third annual Pan-Arab Conference, this year in Beirut. The Black Alumni of MIT (BAMIT) club spent a great deal of the year focusing their efforts on fundraising. The Association of MIT Alumnae (AMITA) hosted a number of new events under the leadership of a newly recruited program chairperson, Gwelle Hsu-Boissiere '98, and membership increased. The alumni affinity group Bisexual, Gay and Lesbian Alumni of MIT (BGALA) continued to host monthly dinners, its Independent Activities Period event, and the Lavender Graduation and Reunion Reception for lesbian, bisexual, gay and transgender graduates and reunion attendees.

Participate

This year, the Association repeated a study done first in 1989 that demonstrated a strong connection between alumni engagement and annual giving. The study examined the donor behaviors of all alumni volunteers, reunion attendees, and club members. Alumni in each group were more likely to be participants in the Alumni Fund, to be regular persistent donors and to make larger gifts. The strong involvement of MIT alumni as participants in Alumni Association activities and as volunteers for the Institute is certainly one basis for the strength of the MIT Alumni Fund. Furthermore, the Institute benefited from the volunteer work of more than 16,000 alumni over the past five years, all of who have given of their time and energy to support MIT in partnership with the staff, students and faculty.

Volunteer Service

The best of this volunteer partnership is manifest in the person who serves each year as president of the Association. In FY2001 this person was L. Robert Johnson '63. Johnson, whose service as a volunteer for the Association has been recognized with the Bronze Beaver and who was awarded the Dalton Bowl for fundraising service to the Institute, shared his enthusiasm with MIT alumni across the country this year. Working with MIT staff, he produced *Staying Close to the Leading Edge*, a presentation that showed alumni the best of MIT's current research as

well as the outstanding young people who study here. His presentation at a large number of MIT clubs, at the Alumni Leadership Conference, and on the web energized viewers and he invited alumni to join him in getting involved. "Not engaging with MIT," he said, is like "holding a winning ticket in the lottery and not claiming it."

Alumni Leadership Conference

Again this year we celebrated the contributions of time and talent of our 6,585 volunteers during the Alumni Leadership Conference on September 21–22, 2001.

More than 340 alumni volunteers and guests returned to campus for this event, with nearly 90 percent registering via the web. Alumni volunteers of all ages and stages of life—from across the United States and around the world—came back to celebrate their achievements, reconnect with campus life and refresh their volunteer skills. Registration for the conference, which had been at an all-time high and had surpassed our goal, was dampened by the tragic events of September 11. While some consideration was given to postponing the ALC weekend, alumni interest remained strong and the conference went ahead as scheduled.

The morning program featured presentations by Chancellor Clay, President Vest, Dean Redwine, associate dean Andrew M. Eisenmann '70, and Richard C. Larson '65, director of the Center for Advanced Educational Services. Each speaker talked about building for MIT's future, including an overview of campus construction and its programmatic impacts, the Institute in the global age, and building beyond the campus walls by including alumni in the life of the Institute. President Vest commented with pride on the campus and alumni responses to the events of September 11 and thanked all present for their confidence in MIT. The afternoon featured workshops for volunteers and concluded with a reception followed by an optional "dine around" that was very well received. Another highlight of the conference was the student-alumni mixer that brought alumni and student leaders together for informal "get-to-know-you" interviews and presentations, and also made for moments of humorous interaction between volunteers and future alumni.

During the Alumni Leadership Conference luncheon, L. Robert Johnson '63 presented Association awards and commendations for their hard work to 22 individual alumni and six groups. These awards were recommended by the Awards Committee and approved by the Board of Directors at the June 2001 meeting.

Bronze Beaver Awards for distinguished service to MIT, the highest Association recognition honor went to Gregory K. Arenson '70, Leon M. Kaatz '64, and Milton H. Roye Jr. '78.

Harold E. Lobdell '17 Distinguished Service Awards for sustained alumni relations service of special depth went to Michael E. Brose '58; Sivavong Changkarsiri '58; Geoffrey A. Clough, SM '72; Arthur E. Cole '68; Barbara A. Crane '77; Robert V. Ferrara '67; Dora Leong Gallo, MCP '92; Linda E. Morecroft, SM '86; and Koji Sasaki, SM '70.

George B. Morgan '20 Awards for excellence in service to the Educational Council went to Vincent W. James '78; Sandra H. Seale, PhD '83; and Lindsey L. Spratt '77.

Henry B. Kane '24 Awards for exceptional fund-raising service and accomplishment went to Thomas C. Davis '84; Mark Gorenberg '76; Judy C. Lewent, SM '72; Donald E. Shobrys '75; Stanley H. Sydney '52, SM '54; Richard M. Tavan '70; and Chiquita V. White '85.

Presidential Citation Awards, given to alumni volunteer groups for distinguished service, went to the Robert A. Swanson '69 Memorial Scholarship Fund, the Class of 1975 25th Reunion Gift Committee, the Class of 1997 Pi Reunion, the MIT Club of Great Britain 50th Anniversary Celebration, the Department of Civil and Environmental Engineering Alumni Day/Harleman Professorship Committees, and the Department of Aeronautics and Astronautics Alumni Day Celebration Planning Committee.

Honorary Membership (presented at the Technology Day luncheon, June 9, 2001) was awarded to Thomas R. Henneberry HM and Bonnie S. Jones HM.

National Selection Committee

The Association has the responsibility for nominating one-third of the term members of the MIT Corporation. These nominees are selected by the National Selection Committee (NSC), chaired this year by Robert A. Muh '59, past president of the Association. The NSC also selects the president of the Association and all term members of the Association Board of Directors. Members of the National Selection Committee, elected by the alumni in a worldwide election each spring, include Robert A. Muh '59, chair; Lita L. Nelsen '64; Arnold A. Kramer '52; Kenneth S. Brock '48; Edwin H. Baker '56; James H. Koenig '87; Viguen R. Ter-Minassian '64; Frances R. Scovil '78; Arlene F. Taylor '83; Cordelia M. Price '78; Barbara A. Crane '77; and Ronald B. Koo '89.

The NSC has named the following alumni to MIT and Association positions for the year beginning July 2, 2002 for FY2003.

Named to the MIT Corporation for five-year terms were Mark R. Epstein '63, L. Robert Johnson '63, and Jorge E. Rodriguez '60.

James A. Lash '66 was named Association president-select to serve as president FY2003.

Rafael Bras '72 and Sandra W. Morgan, PhD '83 were named as Association vice presidents for two-year terms.

Named as Association district directors for two-year terms were Jonathan M. Goldstein '83, Cynthia Helsel Skier

'74, William L. Maini '51, Kenneth Wang '71, Marc J. Chelemer '81, and John D. Chisholm '75.

Annalisa L. Weigel '94 was named Association young alumni representative for a two-year term.

National Boards and Committees

During this year, 80 alumni served as members of Association national boards and committees. These committees have been led by the following volunteers: Gregory E. Moore '73, Alumni Fund Board; Scott P. Marks Jr. '68, Alumni Fund Goals Committee; Karen W. Arenson '70, Awards Committee; Mark Y.D. Wang '87, Committee on Nominations for Corporation Visiting Committees; Matthew K. Haggerty '83, Enterprise Forum Board; Robert M. Muh '59, National Selection Committee; and Hollie K. Schmidt '87, Technology Day Committee.

The Alumni Fund and the Parents Fund

MIT's alumni, parents, graduating seniors, and friends have demonstrated once again that they are invested in the Institute, and its faculty and students. In a year of tremendous economic and political turbulence, 28,626 alumni and graduating seniors, 1,900 parents and friends and 503 matching gift companies combined to raise an Alumni Fund of $30.02 million, exceeding the FY2002 goal of $30 million. Gregory E. Moore '73, chair of the Alumni Fund Board, led a cadre of fund volunteers who sent letters, made phone calls, and spoke personally with their fellow alumni to achieve these results. This, the third largest fund in MIT's history, is a remarkable result and bears testimony to the strong commitment by MIT alumni to the Institute.

Included in these results is the Parents Fund that set a participation record of 1,399 parent donors. The Parents Fund, ably led by Thomas and Nicole D. Hynes, P'02, also set records for donors at all gift levels except the $10,000-and-above level. A new Honor with Books gift incentive program for parents was very successful, generating 89 gifts from senior parents. One in four of these gifts were from first-time parent donors.

This was a year when the Alumni Fund concentrated a great deal of effort on participation and fell short of our participation goal by only 99 donors. Undergraduate alumni participation increased by more than 300 donors, reversing a five-year trend. Graduate alumni participation was dampened by the unfortunate timing of the first solicitation letters, mailed just after the events of September 11. The graduate degree-only alumni numbers never recovered from that slow start and total graduate degree-only participation dropped by more than 450 donors.

Online giving is a priority, and with the unveiling of the new *Giving to MIT* web site, a joint venture of the Association and Resource Development, it is now easier and more convenient than ever for donors. The number of online donors increased by more than 90 percent as 951 donors gave a total of $188,771, compared to just 495 online donors in FY2001.

Results and Measurements

(Note: all dollar amounts reflect the Alumni Fund $100,000 cap)

Criteria	FY02 Results	FY01 Results	FY01/02 Results	FY02 Goal	FY01/02 Goal
Total Alumni Fund	$30.02M	$33.06M	($3.04M)	$30M	($1.6M)
Undergraduate					
# Donors to Fund	18,311	17,968	343	17,975	(1,125)
# Donors > $500	3,397	3,507	(110)	3500	0
% Donors > $500	18.6%	19.5%	(.9%)	19.5%	1.2%
# First-time Donors	1,019	743	276	750	(150)
Graduate Degree Only					
# Donors to Fund	10,315	10,758	(443)	10,750	(550)
# Donors > $500	1,274	1,350	(22)	1,300	0
% Donors > $500	12.4%	12.5%	(.1%)	12.1%	0.6%
# First-time Donors	552	730	(178)	750	(150)
Total					
# Donors to Fund	28,626	28,726	(100)	28,725	(1,675)
# Donors > $500	4,671	4,857	(186)	4,800	(0)
% Donors > $500	16.3%	16.9%	(0.6%)	16.7%	0.9%
# First-time Donors	1,571	1,473	98	1,500	(300)
Total Giving > $2,000					
# Donors > $2,000	1,262	1,354	(92)	1,300	(100)
% Donors > $2,000	4.4%	4.7%	(.3%)	4.5%	(0.1%)
Total Giving > $5,000					
# Donors > $5,000	678	726	(48)	675	(75)
% Donors > $5,000	2.4%	2.5%	(0.1%)	2.3%	(.2%)
Parents Fund					
Total $s	$364,862	$358,119	$6,743	$400,000	$0
# Donors	1,399	1,049	350	1,200	0

Phonathons continued to account for more than one-third (10,908) of donors to the Alumni Fund, raising $1.59 million in FY2002. The Tech Caller program, our program of paid MIT student callers, enjoyed a very strong year, securing $809,423 from 5,724 donors. Our departmental phonathon program, held every fall, raised $204,320 from 1,324 donors. The Association's student program recruited 322 volunteer callers for the student and athletic phonathons, raising $187,020 from 1,316 alumni. We outsourced elements of our calling, working with the firm RuffaloCODY, a telemarketing firm specializing in non-profit fundraising. RuffaloCODY raised $106,569 from 1,107 donors.

Reunion Giving

The reunion classes celebrating their quinquennial reunions in June—the 2s and 7s—set a record for cumulative reunion giving. This year's reunion classes generously contributed an amazing $90.62 million to their collective reunion gift campaigns. That $90.62 million total shattered the mark of $76.29 million set just last year by the 2001 reunion campaign. This year's record-breaking effort comes thanks to the hard work of 14 different gift committees and their 155 volunteers, and highly successful fund-raising for The Campaign for MIT. Highlights included record-breaking gifts for the 40th and 60th reunion classes of $41.96 million and $15.48 million, respectively, and $13.24 million from the class of 1952's 50th reunion gift.

Class Year	Reunion Year	Gift Total	Participation
1922	80	$1,944,484	n/a
1927	75	$1,848,323	27%
1932	70	$2,577,656	60%
1937	65	$4,961,243	77%
1942	60	$15,483,705	75%
1947	55	$990,734	47%
1952	50	$13,243,719	63%
1957	45	$452,280	46%
1962	40	$41,961,856	61%
1967	35	$1,187,518	48%
1972	30	$1,972,360	48%
1977	25	$3,678,356	64%
1982	20	$137,820	39%
1987	15	$96,094	35%
1992	10	$57,340	24%
1997	5	$27,490	23%
Total		**$90,615,978**	

The Young Alumni Campaign

At the start of The Campaign for MIT, the Alumni Fund decided to target undergraduate alumni in the 10 most recently graduated classes in an effort to reverse the trend of decreasing young alumni participation. The 18-member Young Alumni Campaign Committee, chaired by Sang Y. Han II '93 and Annalisa Weigel '94, rode the momentum of a program started in FY2001 to remarkably successful results in FY2002.

Continuing with the theme of *Participate, Designate, Make a Difference*, the Young Alumni Campaign brought in 861 first-time donors, including members of the class of 2002. Among the young alumni classes a total of 2,398 donors contributed to the Alumni Fund, a 23 percent overall participation rate and a three percent increase over FY2001. These efforts were recognized by the Council for the Advancement of Secondary Education (CASE), which awarded the Young Alumni Campaign a Circle of Excellence award in May. The Senior Gift reported 31 percent participation and raised $38,230 in gifts and pledges from 324 class members. This campaign was again aided by the Fibonacci Challenge, funded this year by L. Robert Johnson '63. Johnson's challenge added $7,110 to the senior gift this year, and will continue to match pledges as they are fulfilled in the coming four years.

Personal Solicitations

Association staff in reunion giving, the graduate alumni program, and the parents program have been working with Resource Development to solicit major gifts prospects for gifts of $50,000 to The Campaign for MIT. The Parents Fund Committee was more effective in its personal solicitations this year as the 18 members (households) on the committee generated three times the number of gifts (89) and five times the amount of money ($32,036) as FY2001. The Parents Fund major gift program was continued with 33 qualification and cultivation visits made to non-alumni parent prospects, with one "still pending" solicitation made. The Graduate Alumni Programs staff traveled to several of our major markets and spent time qualifying prospects there, including a total of 200 graduate degree-only donor prospects this year. These efforts are in addition to the traditional personal solicitation efforts of our reunion gift committees.

Other Fundraising Initiatives

The Black Alumni of MIT (BAMIT) club spent a great deal of the year focusing their efforts on raising funds for the new Wesley Harris Fund, which will support MITE2S scholars. The fund-raising effort took off under BAMIT leadership and the group reached its original goal of $100,000. That goal was then raised to $200,000. Special events were held in Boston and in Chicago to raise awareness of MITE2S and this newly named fund.

MIT has 12,717 international alumni, about 80 percent of them graduate degree-only alumni. Finding vehicles through which these alumni can support the Alumni Fund is an ongoing effort. This year, a mailing for international graduate alumni sent out in April raised $38,795 from 167 donors, building on the strong results of a similar mailing from last year.

The Capital Campaign

The Association continues its close collaboration with Resource Development in support of The Campaign for MIT. By the end of FY2002, 50 percent of all alumni had made gifts to the campaign. The Alumni Fund set a Capital Campaign goal of $230 million in cumulative annual gifts, which could be described as the largest single gift in the campaign. The fund reports that we are on target to achieve that goal with total campaign gifts in the Alumni Fund by year-end standing at $153.4 million.

One obvious result of this continued partnership was the launch in October 2001 of the new, consolidated and vastly improved *Giving to MIT* web site. This new site provides alumni donors and volunteers, as well as MIT staff, with an information-rich site about making gifts to the Institute. Throughout the site, we have included profiles of Institute donors from every level of the gift pyramid, from young alumni donors to the Alumni Fund to the multi-million dollar donors to The Campaign for MIT. The staff of the Alumni Fund worked closely with Resource Development to support and broadcast, to a wider audience, the fund-raising messages of The Campaign for MIT through a number of initiatives.

Alumni Engagement in MIT Education

Through the MIT Council on Educational Technology (MITCET) and the d'Arbeloff Fund for Excellence in Education, administered by the MITCET, several faculty members and student groups worked with the Association and the Office of the Dean for Undergraduate Education to engage alumni in the education of current MIT students. This year we recorded the participation of nearly 400 alumni in these activities. Many other alumni were invited by faculty to contribute their experience and expertise as an additional resource in MIT's classrooms. For example, alumni are serving as industry experts in the School of Engineering's new Undergraduate Practice Opportunities Program; as internship sponsors in the Freshman Alumni Summer Internship Program, started with Alumni Association help in 1998; as panelists in programs arranged by the Graduate Student Council; and in the Sloan School as alumni mentors.

My sense is that this development, now concluding its second year under the MITCET, has the potential to become a huge innovation for enriching the education of MIT's students and engaging alumni in substantive, meaningful ways on behalf of the Institute. It will continue to get the attention of alumni leaders and our staff as MIT explores its commitment to encouraging these opportunities for alumni engagement. Greg Moore '73 has represented the Association as a member of the MITCET for this year.

Services in Support of Volunteers

One can view the Association as an international organization with a large sales force (our 6,585 alumni volunteers) located all around the world. In this context, it is easy to see why a major portion of our resources must be dedicated to training and support of volunteers. One example is the support we provide to hundreds of Alumni Fund volunteers on reunion class gift committees, which this year raised $90.62 million in gifts and pledges from members of this year's reunion classes, an all-time record.

Our service to alumni groups remains extremely strong. We had more visits in the field, and more training in groups and one-on-one. Additional online tools were offered to our alumni volunteers. We are hosting more class and club web sites than ever on the alum server, and 243 alumni-created group email lists are now in use. Our online service of downloadable lists and labels for volunteers caught on to a great degree, and more than 100 lists were downloaded for club leaders via the Infinite Connection.

Face-to-face interaction with our volunteers is an ongoing day-to-day activity of most of the Association staff in the field and on campus. In addition we planned leadership development events at MIT and in the regions as we do each year. This year the Alumni Leadership Conference (ALC), our annual volunteer event, included meetings with club leaders and class committees, workshops for the Educational Council and training on the Infinite Connection. The annual Enterprise Forum Chapter Leadership Conference was held in Cambridge October 6–7, 2001.

At the ALC, the Alumni Travel Program joined the Clubs And Affinity Groups by launching an ad hoc advisory group. This group, made up of previous travelers and faculty speakers for the program, has provided invaluable guidance in its first year. In addition the Alumni Travel Program has recruited past travelers to participate in the new online travel ambassador program.

Online services in support of volunteers continue to grow and improve. Events registration online has increased across the spectrum of Association activities: ALC, 87 percent of registrations; Family Weekend, 71 percent; and Tech Reunions, 65 percent, up from 41 percent last year. For Tech Reunions this year, we implemented a new events-system reporting package provided by our database vendor. We added a toolkit for departments to the other online tools available to our volunteers. Web sites hosted on alumweb for volunteer groups increased in number this year with class sites increasing from 49 to 57, and club sites from 38 to 42. We continue to support email lists for most classes and clubs and many other volunteer alumni groups. This year we added online post-event evaluations to our set of services.

We continue to test and evaluate online elections. The Alumni Association manages the election of the young alumni Corporation representative. In 2001, R. Robert Wickham '93, chairman of the Corporation Screening Committee that selects nominees for this position, worked closely with the Association's Alumni Network Services staff to create an online ballot for the voters. This move from a paper ballot to an online ballot has proved to be very popular with the voters. Voter turnout increased significantly from an average 6.5 percent in recent years to 8.5 percent in 2001 and 10.5 percent in 2002. We offered alumni an online option for voting for the National Selection Committee, which was selected by 11 percent of those voting. The senior class election was held online this year, with 342 voters, a significant increase over the previous year's paper balloting. Several reunion classes continued the experiment with online class elections begun last year. We are evaluating these results to determine if this method for class elections is better than elections held during the reunion events.

During this year a great deal of staff and volunteer time was dedicated to the development of a set of requirements for online support of events, both on-campus and in the field. A request for proposals was issued in spring 2002 to identify a vendor to work with the Association to develop the first phase of these transactional services that we are calling SmarTrans. This project will build a system to offer simple online event registration and dues collection, and will be of value to both the Association and its many volunteer groups. The implementation of this service will provide the Association with better alumni participation data to inform program planning, will give us the capacity to handle real-time online credit card transactions and will improve our contact information on alumni, while at the same time giving alumni groups access to services that will improve their ability to manage MIT events in the field.

Explore

One of the most valuable services the Association provides for alumni is the opportunity to explore the richness of the research and education community at MIT. The video produced this year by L. Robert Johnson '63 is a good illustration of what the Association can do to help alumni explore MIT. For alumni who don't make it to campus as frequently as he does, Johnson wanted to re-create the excitement he feels about MIT. He assembled a presentation with videos of cutting-edge research, images of new buildings being built around the campus and the sights and sounds of student activities. When he gave the presentation, alumni reaction confirmed his expectations—they responded enthusiastically. Now we have posted this presentation as an online video on the Alumni Association web site.

During the fall, under Johnson's leadership, the Association Board of Directors developed a white paper on what lifetime educational opportunities alumni would like from MIT. The thesis of this paper, sent to Provost Robert Brown and to Richard C. Larson '65, the director of the Center for Advanced Educational Services, is that alumni want to be able to explore the broad variety of things that happen on the MIT campus every day. The Association provides a number of services that help alumni explore MIT, including the Alumni Seminars program in which faculty visit clubs around the world; the MIT On the Road program of seminars presented by MIT faculty members in selected areas each year; the Enterprise Forum regional chapter programs and MIT-based satellite broadcasts; the Alumni Travel Program trips, often accompanied by MIT faculty; and a variety of online services offered through our comprehensive Association web site.

Alumni Seminars and MIT On the Road

Bringing MIT alumni and faculty together through the Alumni Seminars and MIT On the Road (MOTR) programs is one of the most successful and popular activities on the list of Association's services. This year, through our Alumni Seminars program, 87 presentations were made worldwide by MIT faculty and administrators, with more than 4,500 alumni and guests in attendance. The popular MOTR program held three seminars this year, attended by 333 alumni and guests. These daylong events, featuring presentations by three to four faculty members, were held in Denver, Northern California and Hartford, CT. We continued to experiment with email and web marketing to increase participation in MOTR, with messages from the Association president, the local club presidents and myself.

Enterprise Forum

The MIT Enterprise Forum headquarters in the Alumni Association produces three satellite broadcasts each year, conducted before a live audience on the MIT campus and transmitted to Forum chapters and MIT clubs around the world. The first satellite broadcast scheduled last year was to have been on September 11, 2001, but it was postponed until April 16, 2002. *Cashing Out Successfully: Exit Strategies to Capture Value* was moderated by Mark Borden, the Hale and Dorr Corporate Department Chair, and featured serial entrepreneur James E. Nicholson '60. The January 24, 2002, broadcast of *New Ventures and Venture Capital: Dealing with the Current Environment* was moderated by Kenneth P. Morse '68 and included alumnus panelist Alan G. Spoon '73, managing general partner at Polaris Ventures. The final panel on *Winning in the Marketplace: Successful Entrepreneurs Tell How They Did It* was scheduled as a prelude to Tech Reunions on June 5, 2002, and was moderated by Sloan School professor Glen D. Urban and included Nicholas G. Lazaris '72, president, CEO, and director of Keurig Inc. Programs this year were received in 57 locations, including Mexico and Singapore, with a total global attendance of approximately 3,000 (including 600 MIT alumni).

In addition to the activities of the MIT headquarters office, the Enterprise Forum, founded in 1978, consists of 24 chapters worldwide. These regional chapters sponsored more than 250 events with well over 26,000 attendees. These events were organized through the efforts of approximately 300 volunteer leaders, many of them MIT alumni.

MIT Alumni Travel Program

Alumni and others who travel with the MIT Alumni Travel Program have the opportunity to explore the world with other MIT people and often to travel with MIT faculty experts. Following the tragedy of September 11, the Alumni Travel Program experienced a number of cancellations and a reduction in reservations throughout the first half of the fiscal year. But by early 2002, alumni interest in travel began to bounce back and the year ended with a total of 500 travelers taking 39 trips. Even so, by the end of the year, travel lagged considerably behind the record-breaking year of FY2001.

MIT faculty experts accompanied alumni on 20 percent of the trips and special MIT-exclusive arrangements were developed for eight programs. The special arrangements made by the Alumni Travel Program for MIT travelers to meet local alumni in Salt Lake City, Shanghai, Wellington, New Zealand, Berlin, Edinburgh and New Orleans fostered renewed MIT interest in cities where alumni programs seldom occur. Two mini-reunion trips and a trip for the young alumni target audience will be piloted in FY2003.

The Alumni Travel Program continues to be innovative in its use of the web and email to market the program to an increasing number of alumni. The web site is refreshed frequently with images from recent trips, and the new online travel ambassadors program offers new travelers the opportunity to connect with seasoned travelers. More than 700 alumni are on the Travel Program email list, up 55 percent over last year. More web links pertinent to each trip have been added to the site to answer alumni questions.

Exploring MIT Online

The Alumni Association web site is one of the best tools we offer alumni to explore the intensity of MIT. On our web site, we invite alumni to visit the *openDOOR*, our award-winning online magazine about MIT. This web site features topics of current interest and links to relevant sites on MIT web pages. Topics this year included:

- June 2002: Meet the 2002 Graduates
- May 2002: Language and Literature
- April 2002: Next Generation Computing
- March 2002: MIT Working in the World
- February 2002: Tiny Technologies
- January 2002: New and Future Media
- December 2001: On Stage at MIT
- November 2001: Mobility Turns the World
- October 2001: Bioengineering and Beyond
- September 2001: MIT's Leading Edge
- July/August 2001: The Oceans' Embrace

In addition to *openDOOR*, the *What Matters?* series gives individual alumni an opportunity to speak out on topics of particular interest to them. Topics during the year have been as varied as genealogy research, computer games, technology and entertainment, and a reunion diary by a class secretary.

The Association partnered with the Center for Advanced Educational Studies to launch MIT World, an online archive of campus events and presentations, available on demand. Active promotion of these videos on the web site and in our email vehicles increased alumni viewing of these presentations that include Wolfgang Ketterle's presentation of his Nobel Prize research and the 2002 Technology Day program. After the first full year of its operations, the MIT World archive now offers 70 presentations from 18 different MIT sources.

Information on all the activities listed above is available on the Alumni Association web site. Alumni can register for MIT On The Road, learn about upcoming trips through the Alumni Travel Program, and find out about faculty speakers scheduled for club presentations around the world. Our web site directs alumni to the MIT events calendar, MIT publications such as *Tech Talk*, *Spectrum* and *The Tech*, MIT Library Resources for alumni, and *Technology Review*.

Association staff conducted an exhaustive review of our web site with the assistance of a web usability expert and other staff from the Institute. This review is forming the basis for a redesign of the current Association site with an eye toward making a very complex site more "user friendly."

Operations

Managing and coping with change has been a significant focus for all the Association staff over the course of the year. A new management structure and the relocation of approximately a third of our staff created major challenges for the organization.

Managing Change

On October 1, 2001, I announced the appointment of Elizabeth A. Garvin HM as managing director of the Association. Garvin continues to hold the position of director of the Alumni Fund as well. This appointment changed the reporting structure for most of the Association senior staff, many of whom are now assigned to report to the managing director rather than to the executive vice president. Monica Ellis '91, director of class programs and Amy Schrom, director of fund appeals, marketing

and stewardship, filled two new senior staff positions. By year's end, through the excellent cooperation of each manager, these new relationships have been forged and the organization is functioning at a high level of effectiveness. The appointment of a managing director makes it possible for me to dedicate more of my time to the important work of building relationships and planning for the future.

In the second of two major relocations in as many years, a third of our staff was moved from the heart of campus in Building 10 to West Campus. The result of this move is that our staff is now located in three widely separated campus locations, in roughly the same group size. The move in summer 2000 of our Operations and Support Services and Alumni Network Services units to W92 has had the benefit of putting our technical staff in a common location. The move of the Enterprise Forum and the Alumni Activities and Geographic Programs units to W59 in December 2001 has separated roughly half the staff that works on alumni activities and fundraising from the other half. We have revised meeting schedules, planned informal staff gatherings and established regular office hours in each location for senior staff. The entire Association continues to meet these challenges with a positive attitude.

Supporting Functions

The smooth functioning of a complex organization such as the Alumni Association depends on effective support from staff who work in the areas of personnel, finance, network support, mail services, programming and systems maintenance, space assignments, renovations, telecommunications and information systems management, including data entry.

Office Relocation

As noted above, the Association has continued a major, multi-year relocation effort that included significant renovations and move coordination. These renovations and relocations required planning, designing, network support, computer/server relocation and security preparations, as well as many other minute details. Association staff from the Operations and Support Services unit accomplished these relocations and renovations with only minor interruption to the ongoing business of the Association.

MIT Alumni Register 2002

The first new Alumni Association directory since 1994 was published this year. A major database update was completed in preparation for the new register. This publication includes reports on the history of the Association and of MIT and, for the first time, photographs of the Institute. Demographic data and a complete listing of all alumni is also a feature of the register. While we have a widely used online alumni database, many alumni still want to have a publication for reference. To date 3,000 copies of the register have been sold.

Staff Awards and Recognition

As a part of the Institute's Infinite Mile Award program the Association offers a staff award program that includes annual awards presented to an outstanding staff member and team, the Joseph S. Collins HM Awards. In July 2001 the first recipients of the Collins Awards were announced. Joseph Recchio received the individual award of $1,000, and the team award of $2,000 was given to the Web Content Team, whose members include Louis Alexander, Margaret Bruzelius, Melissa Chapman Gresh, Eve Downing, Elizabeth Durant, Susan Maynard, Jonathan Slate, and Nancy Duvergne Smith. Additionally, 61 Appreciation Awards (a $25 gift certificate) were given to staff throughout the course of the year to individuals who went out of their way to do an outstanding job and to be helpful to other staff.

Alumni Records and Reporting

Working with Information Systems, a team from the Operations and Support Services unit successfully implemented a new method for online credit card processing, resulting in improved speed, efficiency and lower costs when processing credit card transactions.

The Data Entry Team recorded nearly 50,000 gifts and pledges this year, including in excess of 8,000 credit card gifts, a new record. This team also processed thousands of updates to the biographical and other demographic information that we maintain on our alumni and friends. To provide the management information required by the Association program managers, the programming staff manages thousands of production reports each month, including hundreds of ad hoc requests.

Personnel

The total headcount for the Alumni Association is 91. During the year, we saw 11 terminations, 14 new hires and five promotions. Gregory Bourne was promoted to technical coordinator, Cynthia Chomka to alumni affairs officer II and, as noted above, Elizabeth A. Garvin HM to managing director, Monica Ellis to director of class programs, and Amy Schrom to director of fund appeals, marketing and stewardship.

William J. Hecht '61
Executive Vice President and CEO

More information about the Alumni Association and its activities can be found on the web at http://web.mit.edu/alum/.

Appendix A: Number of Degrees Awarded 2001–2002

OFFICE OF THE REGISTRAR

	S.B.	S.M.	M.Arch, MCP M.Eng, MBA	Engineer	PhD	ScD	Total
SCHOOL OF ARCHITECTURE							
Architecture	-	-	32	-	12	-	44
Architecture Studies	-	21	-	-	-	-	21
Art and Design	19	-	-	-	-	-	19
Building Technology	-	2	-	-	-	-	2
Media Arts and Sciences	-	38	-	-	10	-	48
Undesignated	-	1	-	-	-	-	1
Media Technology	-	1	-	-	-	-	1
Planning	6	-	-	-	-	-	6
Real Estate Development	-	31	-	-	-	-	31
Urban Studies and Planning	-	1	58	-	8	-	67
Visual Studies	-	1	-	-	-	-	1
Total	25	96	90	-	30	-	241
SCHOOL OF ENGINEERING							
Aeronautics and Astronautics	4	68	1	1	23	-	97
Undesignated	-	1	-	-	-	-	1
Aerospace Engineering	30	-	-	-	-	-	30
Aerospace Eng. Information Technology	12	-	-	-	-	-	12
Biological Engineering	-	2	-	-	6	-	8
Biomedical Engineering	-	-	4	-	-	-	4
Chemical Engineering	72	11	-	-	30	2	115
Undesignated	10	-	-	-	-	-	10
Chemical Engineering Practice	-	29	-	-	-	-	29
Civil Engineering	3	-	-	-	-	-	3
Civil and Environmental Engineering	-	46	42	-	14	3	105
Undesignated	2	5	-	-	-	-	7
Computer Science and Engineering	161	-	-	-	-	-	161
Electrical Science and Engineering	59	-	-	-	-	-	59
Electrical Engineering and Computer Science	156	95	198	3	68	5	525
Engineering and Management	-	47	-	-	-	-	47
Environmental Engineering Science	12	-	-	-	-	-	12
Logistics	-	-	30	-	-	-	30
Materials Science and Engineering	29	12	5	-	15	1	62
Undesignated	3	1	-	-	-	-	4
Mechanical Engineering	92	86	-	1	33	2	214
Undesignated	10	10	-	-	-	-	20
Naval Architecture and Marine Engineering	-	12	-	-	-	-	12
Naval Engineer	-	-	-	3	-	-	3
Nuclear Engineering	6	15	-	2	11	-	34
Ocean Engineering	6	8	-	-	3	-	17
Ocean Systems Management	-	7	-	-	-	-	7
Technology and Policy	-	35	-	-	-	-	35

Technology, Management and Policy	-	-	-	-	7	-	7
Toxicology	-	5	-	-	-	-	5
Transportation	-	23	-	-	1	1	25
Total	667	518	280	10	211	14	1,700
SCHOOL OF HUMANITIES, ARTS, AND SOCIAL SCIENCE							
Anthropology	1	-	-	-	-	-	1
Comparative Media Studies	-	10	-	-	-	-	10
Economics	46	-	-	-	22	-	68
Foreign Languages and Literatures	1	-	-	-	-	-	1
History	1	-	-	-	-	-	1
Humanities	6	-	-	-	-	-	6
Humanities and Engineering	5	-	-	-	-	-	5
Humanities and Science	3	-	-	-	-	-	3
Linguistics	-	-	-	-	7	-	7
Linguistics and Philosophy	3	-	-	-	-	-	3
Literature	6	-	-	-	-	-	6
Music	1	-	-	-	-	-	1
Philosophy	1	-	-	-	4	-	5
Political Science	7	4	-	-	6	-	17
Science, Technology, and Society	-	-	-	-	3	-	3
Writing	4	-	-	-	-	-	4
Total	85	14	-	-	42	-	141
SLOAN SCHOOL OF MANAGEMENT							
Management	-	27	391	-	16	-	434
Undesignated	-	1	-	-	-	-	1
Management Science	104	-	-	-	-	-	104
Management of Technology	-	55	-	-	-	-	55
Operations Research	-	5	-	-	6	-	11
Total	104	88	391	-	22	-	605
SCHOOL OF SCIENCE							
Atmospheric Science	-	1	-	-	-	-	1
Biology	71	6	-	-	35	-	112
Undesignated	23	-	-	-	-	-	23
Brain and Cognitive Sciences	39	2	-	-	12	-	53
Chemistry	32	7	-	-	34	-	73
Climate Physics and Chemistry	-	1	-	-	-	-	1
Earth and Planetary Sciences	-	8	-	-	-	-	8
Earth, Atmospheric, and Planetary Sciences	7	-	-	-	16	-	23
Geosystems	-	3	-	-	-	-	3
Mathematics	76	3	-	-	21	-	100
Mathematics with Computer Science	9	-	-	-	-	-	9
Physics	49	2	-	-	33	-	84
Total	306	33	-	-	151	-	490

WHITAKER COLLEGE of Health Sciences and Technology							
Health Sciences and Technology	-	-	-	-	16	-	16
Medical Informatics	-	3	-	-	-	-	3
Total	-	3	-	-	16	-	19
Awarded Jointly with Woods Hole Oceanographic Institution:							
Biology	-	1	-	-	5	-	6
Civil and Environmental Engineering	-	-	-	-	2	-	2
Earth, Atmospheric, and Planetary Sciences	-	2	-	-	6	-	8
Electrical Engineering and Computer Science	-	1	-	-	-	-	1
Mechanical Engineering	-	1	-	-	-	-	1
Ocean Engineering	-	2	-	-	2	-	4
Grand Total	1,187	759	761	10	487	14	3,218

Enrollment Statistics, Fall 2001

NUMBER OF STUDENTS BY COURSE AND YEAR

October 5, 2001

FALL TERM 2001-2002 — OFFICE OF THE REGISTRAR

Course	Year 2	3	4	5	Total Under-Master grads	Doctoral Eng.	Reg.	Non-Res.	Spec	l.	Total Grads	Grand Total	Course Number
SCHOOL OF ARCHITECTURE AND PLANNING													
Architecture, IV	24	18	13	4	59	163	41	16	1		221	280	IV
Architecture, IV-B	-	1	-	-	1	-	-	-	-		-	1	IV-B
Urban Studies and Planning, I	3	4	5	-	12	139	45	18	2		204	216	I
Program in Media Arts and Sciences, MAS	-	-	-	-	-	73	78	-	1		152	152	MAS
Total	27	23	18	4	72	375	164	34	4		577	649	Total
SCHOOL OF ENGINEERING													
Aeronautics and Astronautics, VI	-	-	-	-	-	158	71	1	2		232	232	VI
Program 1 - Aerospace Engineering, VI-1	48	59	32	6	145	-	-	-	-		-	145	VI-1
Program 2 - Aerospace Eng. with Information Technology, VI-2	8	10	12	1	31	-	-	-	-		-	31	VI-2
Aeronautics and Astronautics, VI-C Internship	-	-	2	-	2	-	-	-	-		-	2	VI-C
Chemical Engineering,	42	55	71	4	172	53	152	2	4		211	383	
Chemical Engineering, -C	1	1	4	2	8	-	-	-	-		-	8	-C
Civil and Environmental Engineering, I	-	-	-	-	-	180	82	6	1		269	269	I
Civil and Environmental Engineering, I-A	-	-	2	-	2	-	-	-	-		-	2	I-A
Civil and Environmental Engineering, I-C	12	14	2	1	29	-	-	-	-		-	29	I-C
Civil and Environmental Engineering, I-E	12	10	9	-	31	-	-	-	-		-	31	I-E
Civil and Environmental Engineering, I-W Woods Hole	-	-	-	-	-	-	6	-	-		6	6	I-W
Electrical Engineering and Computer Science, VI	-	-	-	-	-	167	452	-	38		657	657	VI
Program 1 - Electrical Science and Engineering	45	34	36	9	124	-	-	-	-		-	124	VI-1
Program 2 - Electrical Engineering and Computer Science	226	170	147	11	554	-	-	-	-		-	554	VI-2
Program 3 - Computer Science and Engineering	71	119	112	15	317	-	-	-	-		-	317	VI-3
Electrical Engineering and Computer Science, VI-P M.Eng.	-	-	-	-	-	225	-	-	-		225	225	VI-P
Electrical Eng and Computer Science, VI-PA M.Eng., Internship	-	-	-	-	-	10	-	-	-		10	10	VI-PA
Program 1 - Electrical Science and Engineering	-	4	8	-	12	-	-	-	-		-	12	VI-1A
Program 2 - Electrical Engineering and Computer Science	-	17	20	1	38	-	-	-	-		-	38	VI-2A
Program 3 - Computer Science and Engineering	-	7	12	1	20	-	-	-	-		-	20	VI-3A
Electrical Engineering and Computer Science, VI-W Woods Hole	-	-	-	-	-	1	1	-	-		2	2	VI-W
Materials Science and Engineering, III	14	10	12	1	37	94	86	-	-		180	217	III
Materials Science and Engineering, III-A	2	-	2	-	4	-	-	-	-		-	4	III-A
Materials Science and Engineering, III-B Internship	17	22	18	-	57	-	-	-	-		-	57	III-B
Materials Science and Engineering, III-C	2	-	1	-	3	-	-	-	-		-	3	III-C
Mechanical Engineering, II	70	64	77	7	218	169	181	-	4		354	572	II
Mechanical Engineering, II-A	6	10	12	3	31	-	-	-	-		-	31	II-A
Mechanical Engineering, II-B Internship	-	7	8	-	15	-	-	-	-		-	15	II-B
Mechanical Engineering, II-W Woods Hole	-	-	-	-	-	1	-	-	-		1	1	II-W
Nuclear Engineering, II	2	6	9	1	18	27	80	-	-		107	125	II
Ocean Engineering, III	6	5	5	1	17	30	16	1	-		47	64	III
Ocean Engineering, III-W Woods Hole	-	-	-	-	-	6	12	-	-		18	18	III-W
Naval Construction and Engineering, III-A	-	-	-	-	-	29	-	-	-		29	29	III-A
Ocean Systems Management, III-B	-	-	-	-	-	8	-	-	-		8	8	III-B
Division of Bioengineering and Environmental Health, BEH	-	-	-	-	-	9	75	-	4		88	88	BEH

Engineering Systems Division, ESD	-	-	-	-	-	113	20	-	-	133	133	ESD
System Design and Management, SDM	-	-	-	-	-	74	-	-	13	87	87	SDM
Total	584	624	613	64	1,885	1,354	1,234	10	66	2,664	4,549	Total
SCHOOL OF HUMANITIES, ARTS, AND SOCIAL SCIENCES												
Economics, IV	19	25	34	4	82	-	108	23	4	135	217	IV
History, I-H	-	1	-	1	2	-	-	-	-	-	2	I-H
Literature, I-L	1	2	2	-	5	-	-	-	-	-	5	I-L
Music and Theater Arts, I-M	1	1	1	1	4	-	-	-	-	-	4	I-M
Writing and Humanistic Studies, I-W	1	1	2	1	5	-	-	-	-	-	5	I-W
Humanities and Engineering, I-E	1	-	4	-	5	-	-	-	-	-	5	I-E
Humanities and Science, I-S	-	-	2	-	2	-	-	-	-	-	2	I-S
Linguistics and Philosophy, IV	1	2	3	2	8	-	63	6	1	70	78	IV
Political Science, VII	4	5	6	2	17	5	58	13	-	76	93	VII
Program in Comparative Media Studies, I-CMS	-	-	-	-	-	20	-	-	-	20	20	I-CMS
Program in Science, Technology, and Society, STS	-	-	-	-	-	-	24	1	-	25	25	STS
Total	28	37	54	11	130	25	253	43	5	326	456	Total
SLOAN SCHOOL OF MANAGEMENT												
Management, V	111	85	80	9	285	757	75	9	21	862	1,147	V
Management Fellows, V-A	-	-	-	-	-	54	-	-	-	54	54	V-A
Operations Research, OR	-	-	-	-	-	9	36	-	1	46	46	OR
Total	111	85	80	9	285	820	111	9	22	962	1,247	Total
SCHOOL OF SCIENCE												
Biology, VII	82	94	69	6	251	3	205	2	4	214	465	VII
Biology, VII-A	-	4	1	1	6	-	-	-	-	-	6	VII-A
Biology, VII-W Woods Hole	-	-	-	-	-	2	32	-	-	34	34	VII-W
Brain and Cognitive Sciences, I	40	35	31	4	110	1	56	1	1	59	169	I
Chemistry, V	31	31	29	2	93	3	234	4	1	242	335	V
Earth, Atmospheric, and Planetary Sciences, II	6	11	5	4	26	10	69	2	1	82	108	II
Earth, Atmospheric, and Planetary Sciences, II-W Woods Hole	-	-	-	-	-	1	50	-	-	51	51	II-W
Mathematics, VIII	56	48	39	5	148	-	117	1	5	123	271	VIII
Mathematics with Computer Science, VIII-C	11	14	9	1	35	-	-	-	-	-	35	VIII-C
Physics, VIII	38	29	38	4	109	10	228	1	4	243	352	VIII
Physics, VIII-A	11	2	3	-	16	-	-	-	-	-	16	VIII-A
Total	275	268	224	27	794	30	991	11	16	1,048	1,842	Total
WHITAKER COLLEGE of Health Sciences and Technology												
Harvard-MIT Division of Health Sciences and Technology, HST	-	-	-	-	-	7	303	-	12	322	322	HST
Center for Advanced Educational Services, CAES	-	-	-	-	-	-	-	-	85	85	85	CAES
Undesignated Sophomores	14	-	-	-	14	-	-	-	-	-	14	UND
First Year	1,033	-	-	-	1,033	-	-	-	-	-	1,033	First Year
Special Undergraduate -- No Course	7	-	-	-	7	-	-	-	-	-	7	Special-NC
Grand Total	71,033	1,039	1,037	989	115	4,220	2,611	3,056	107	210	5,984	10,204	Grand Total

Not included in above totals: Foreign Study: 23 students in the third year, 6 students in the fourth year, and 1 student in the fifth year. Domestic Study: 2 students in the third year and 1 student in the fourth year.							
Non-Institute Brandeis, NIR	-	-	-	-	-	2	2NIR
Non-Institute Harvard, NIH	2	4	12	45	63	253	316NIH
Non-Institute MFA MCA, NIA	-	-	-	6	6	-	6NIA
Non-Institute Tufts, NIT	-	1	-	1	2	-	2NIT
Non-Institute Wellesley, NIW	-	23	22	23	68	-	68NIW
Non-Institute Research Visitor, NIV	-	-	1	7	8	71	79NIV
Non-Institute Exchange, NIE	-	-	33	-	33	10	43NIE
Total	2	28	68	82	180	336	516Total

Number includes 186 students wor ing on Harvard degrees only.

NUMBER OF WOMEN STUDENTS BY COURSE AND YEAR

October 5, 2001

FALL TERM 2001-2002 — OFFICE OF THE REGISTRAR

Course	Year 2	3	4	5	Total Under-grads	Master Eng.	Doctoral Reg.	Non-Res.	Spec'l.	Total Grads	Grand Total	Course Number
SCHOOL OF ARCHITECTURE AND PLANNING												
Architecture, IV	17	12	11	-	40	71	22	9	1	103	143	IV
Architecture, IV-B	-	1	-	-	1	-	-	-	-	-	1	IV-B
Urban Studies and Planning, I	1	2	3	-	6	79	22	11	1	113	119	I
Program in Media Arts and Sciences, MAS	-	-	-	-	-	21	22	-	-	43	43	MAS
Total	18	15	14	-	47	171	66	20	2	259	306	Total
SCHOOL OF ENGINEERING												
Aeronautics and Astronautics, VI	-	-	-	-	-	40	17	-	-	57	57	VI
Program in Aeorspace Engineering, VI-1	17	19	7	2	45	-	-	-	-	-	45	VI-1
Program in Aeorspace Eng. Information Technology, VI-2	7	2	5	-	14	-	-	-	-	-	14	VI-2
Aeronautics and Astronautics, VI-C Internship	-	-	1	-	1	-	-	-	-	-	1	VI-C
Chemical Engineering,	28	28	49	1	106	16	40	1	1	58	164	
Chemical Engineering, -C	1	1	2	2	6	-	-	-	-	-	6	-C
Civil and Environmental Engineering, I	-	-	-	-	-	45	21	2	-	68	68	I
Civil and Environmental Engineering, I-A	-	-	1	-	1	-	-	-	-	-	1	I-A
Civil and Environmental Engineering, I-C	5	10	1	-	16	-	-	-	-	-	16	I-C
Civil and Environmental Engineering, I-E	9	9	6	-	24	-	-	-	-	-	24	I-E
Civil and Environmental Engineering, I-W Woods Hole	-	-	-	-	-	-	2	-	-	2	2	I-W
Electrical Engineering and Computer Science, VI	-	-	-	-	-	41	79	-	8	128	128	VI
Program 1 - Electrical Science and Engineering	18	12	12	1	43	-	-	-	-	-	43	VI-1
Program 2 - Electrical Engineering and Computer Science	53	42	34	3	132	-	-	-	-	-	132	VI-2
Program 3 - Computer Science and Engineering	14	38	31	4	87	-	-	-	-	-	87	VI-3
Electrical Engineering and Computer Science, VI-P M.Eng.	-	-	-	-	-	47	-	-	-	47	47	VI-P
Electrical Eng and Computer Science, VI-PA M.Eng., Internship	-	-	-	-	-	3	-	-	-	3	3	VI-PA
Program 1 - Electrical Science and Engineering	-	1	2	-	3	-	-	-	-	-	3	VI-1A
Program 2 - Electrical Engineering and Computer Science	-	5	5	-	10	-	-	-	-	-	10	VI-2A
Program 3 - Computer Science and Engineering	-	4	3	-	7	-	-	-	-	-	7	VI-3A
Electrical Engineering and Computer Science, VI-W Woods Hole	-	-	-	-	-	-	1	-	-	1	1	VI-W
Materials Science and Engineering, III	10	3	8	1	22	31	22	-	-	53	75	III
Materials Science and Engineering, III-A	2	-	2	-	4	-	-	-	-	-	4	III-A
Materials Science and Engineering, III-B Internship	12	13	11	-	36	-	-	-	-	-	36	III-B
Materials Science and Engineering, III-C	2	-	1	-	3	-	-	-	-	-	3	III-C
Mechanical Engineering, II	19	25	28	1	73	41	20	-	1	62	135	II
Mechanical Engineering, II-A	4	1	6	1	12	-	-	-	-	-	12	II-A
Mechanical Engineering, II-B Internship	-	1	1	-	2	-	-	-	-	-	2	II-B
Nuclear Engineering, II	2	2	3	-	7	7	19	-	-	26	33	II
Ocean Engineering, III	2	3	3	-	8	6	3	-	-	9	17	III
Ocean Engineering, III-W Woods Hole	-	-	-	-	-	-	1	-	-	1	1	III-W
Naval Construction and Engineering, III-A	-	-	-	-	-	3	-	-	-	3	3	III-A
Division of Bioengineering and Environmental Health, BEH	-	-	-	-	-	4	37	-	2	43	43	BEH
Engineering Systems Division, ESD	-	-	-	-	-	29	8	-	-	37	37	ESD
System Design and Management, SDM	-	-	-	-	-	10	-	-	1	11	11	SDM

Total		20	52	19	22	216	662	323	270	3	13	609	1,271	Total
SCHOOL OF HUMANITIES, ARTS, AND SOCIAL SCIENCES														
Economics, IV		9	11	18	2	40	-	35	7	1	43	83	IV	
History, I-H		-	1	-	-	1	-	-	-	-	-	1	I-H	
Literature, I-L		-	2	1	-	3	-	-	-	-	-	3	I-L	
Music and Theater Arts, I-M		1	-	-	1	2	-	-	-	-	-	2	I-M	
Writing and Humanistic Studies, I-W		-	1	-	1	2	-	-	-	-	-	2	I-W	
Humanities and Engineering, I-E		-	-	2	-	2	-	-	-	-	-	2	I-E	
Humanities and Science, I-S		-	-	2	-	2	-	-	-	-	-	2	I-S	
Linguistics and Philosophy, IV		1	1	3	1	6	-	31	3	1	35	41	IV	
Political Science, VII		1	2	4	2	9	4	23	7	-	34	43	VII	
Program in Comparative Media Studies, I-CMS		-	-	-	-	-	14	-	-	-	14	14	I-CMS	
Program in Science, Technology, and Society, STS		-	-	-	-	-	-	11	1	-	12	12	STS	
Total		12	18	30	7	67	18	100	18	2	138	205	Total	
SLOAN SCHOOL OF MANAGEMENT														
Management, V		48	34	42	4	128	192	22	4	5	223	351	V	
Management Fellows, V-A		-	-	-	-	-	8	-	-	-	8	8	V-A	
Operations Research, OR		-	-	-	-	-	1	12	-	-	13	13	OR	
Total		48	34	42	4	128	201	34	4	5	244	372	Total	
SCHOOL OF SCIENCE														
Biology, VII		48	75	48	2	173	1	108	1	3	113	286	VII	
Biology, VII-A		-	3	1	-	4	-	-	-	-	-	4	VII-A	
Biology, VII-W Woods Hole		-	-	-	-	-	1	20	-	-	21	21	VII-W	
Brain and Cognitive Sciences, I		28	27	20	2	77	1	14	-	-	15	92	I	
Chemistry, V		18	17	17	1	53	-	70	2	-	72	125	V	
Earth, Atmospheric, and Planetary Sciences, II		6	9	3	2	20	6	22	-	-	28	48	II	
Earth, Atmospheric, and Planetary Sciences, II-W Woods Hole		-	-	-	-	-	1	30	-	-	31	31	II-W	
Mathematics, VIII		17	15	15	2	49	-	25	-	-	25	74	VIII	
Mathematics with Computer Science, VIII-C		3	5	3	-	11	-	-	-	-	-	11	VIII-C	
Physics, VIII		14	10	11	-	35	3	22	-	2	27	62	VIII	
Physics, VIII-A		4	-	-	-	4	-	-	-	-	-	4	VIII-A	
Total		138	161	118	9	426	13	311	3	5	332	758	Total	
WHITAKER COLLEGE of Health Sciences and Technology														
Harvard-MIT Division of Health Sciences and Technology, HST		-	-	-	-	-	2	94	-	2	98	98	HST	
Center for Advanced Educational Services, CAES		-	-	-	-	-	-	-	-	12	12	12	CAES	
Undesignated Sophomores		5	-	-	-	5	-	-	-	-	-	5	UND	
First Year	428	-	-	-	-	428	-	-	-	-	-	428	First Year	
Special Undergraduate -- No Course	2	-	-	-	-	2	-	-	-	-	-	2	Special-NC	
Grand Total	242	84	264	474	263	1,765	728	875	48	41	1,692	3,457	Grand Total	

NUMBER OF INTERNATIONAL STUDENTS BY COURSE AND YEAR

October 5, 2001

FALL TERM 2001-2002 — OFFICE OF THE REGISTRAR

Course	Year 2	3	4	Total UG	Master Eng.	Doctoral	Spec l.	Total Grads	Grand Total	Course Number
SCHOOL OF ARCHITECTURE AND PLANNING										
Architecture, IV	2	2	-	4	65	27	-	92	96	IV
Architecture, IV-B	-	1	-	1	-	-	-	-	1	IV-B
Urban Studies and Planning, I	-	-	-	-	38	26	2	66	66	I
Program in Media Arts and Sciences, MAS	-	-	-	-	28	28	-	56	56	MAS
Total	2	3	-	5	131	81	2	214	219	Total
SCHOOL OF ENGINEERING										
Aeronautics and Astronautics, VI	-	-	-	-	72	40	1	113	113	VI
Program 1 - Aerospace Engineering, VI-1	3	4	2	9	-	-	-	-	9	VI-1
Program 2 - Aerospace Eng. with Information Technology, VI-2	-	4	1	5	-	-	-	-	5	VI-2
Chemical Engineering,	2	1	7	10	22	45	4	71	81	
Civil and Environmental Engineering, I	-	-	-	-	112	57	1	170	170	I
Civil and Environmental Engineering, I-C	2	1	-	3	-	-	-	-	3	I-C
Civil and Environmental Engineering, I-E	-	1	-	1	-	-	-	-	1	I-E
Electrical Engineering and Computer Science, VI	-	-	-	-	47	152	10	209	209	VI
Program 1 - Electrical Science and Engineering	8	1	4	13	-	-	-	-	13	VI-1
Program 2 - Electrical Engineering and Computer Science	31	12	12	55	-	-	-	-	55	VI-2
Program 3 - Computer Science and Engineering	8	11	8	27	-	-	-	-	27	VI-3
Electrical Engineering and Computer Science, VI-P M.Eng.	-	-	-	-	36	-	-	36	36	VI-P
Electrical Eng and Computer Science, VI-PA M.Eng., Internship	-	-	-	-	2	-	-	2	2	VI-PA
Program 1 - Electrical Science and Engineering	-	2	1	3	-	-	-	-	3	VI-1A
Program 2 - Electrical Engineering and Computer Science	-	6	6	12	-	-	-	-	12	VI-2A
Program 3 - Computer Science and Engineering	-	4	7	11	-	-	-	-	11	VI-3A
Electrical Engineering and Computer Science, VI-W Woods Hole	-	-	-	-	1	-	-	1	1	VI-W
Materials Science and Engineering, III	-	1	-	1	35	42	-	77	78	III
Materials Science and Engineering, III-B Internship	2	2	-	4	-	-	-	-	4	III-B
Mechanical Engineering, II	2	4	6	12	48	96	2	146	158	II
Mechanical Engineering, II-A	-	1	2	3	-	-	-	-	3	II-A
Nuclear Engineering, II	-	2	1	3	7	49	-	56	59	II
Ocean Engineering, III	-	-	-	-	18	12	-	30	30	III
Ocean Engineering, III-W Woods Hole	-	-	-	-	1	5	-	6	6	III-W
Naval Construction and Engineering, III-A	-	-	-	-	8	-	-	8	8	III-A
Ocean Systems Management, III-B	-	-	-	-	4	-	-	4	4	III-B
Division of Bioengineering and Environmental Health, BEH	-	-	-	-	2	30	2	34	34	BEH
Engineering Systems Division, ESD	-	-	-	-	62	9	-	71	71	ESD
System Design and Management, SDM	-	-	-	-	9	-	1	10	10	SDM
Total	58	57	57	172	486	537	21	1,044	1,216	Total
SCHOOL OF HUMANITIES, ARTS, AND SOCIAL SCIENCES										
Economics, IV	2	3	3	8	-	62	2	64	72	IV
Linguistics and Philosophy, IV	-	-	-	-	-	33	-	33	33	IV
Political Science, VII	-	-	1	1	3	18	-	21	22	VII
Program in Comaprative Media Studies, I-CMS	-	-	-	-	9	-	-	9	9	I-CMS

Program in Science, Technology, and Society, STS	-	-	-	-	-	7	-	7	7STS
Total	2	3	4	9	12	120	2	134	143Total
SLOAN SCHOOL OF MANAGEMENT									
Management, V	6	2	8	16	277	55	17	349	365 V
Management Fellows, V-A	-	-	-	-	37	-	-	37	37 V-A
Operations Research, OR	-	-	-	-	5	19	1	25	25OR
Total	6	2	8	16	319	74	18	411	427Total
SCHOOL OF SCIENCE									
Biology, VII	2	6	3	11	1	20	-	21	32VII
Biology, VII-W Woods Hole	-	-	-	-	-	10	-	10	10VII-W
Brain and Cognitive Sciences, I	-	-	1	1	-	17	-	17	18I
Chemistry, V	1	4	3	8	1	82	-	83	91V
Earth, Atmospheric, and Planetary Sciences, II	-	-	-	-	3	25	-	28	28 II
Earth, Atmospheric, and Planetary Sciences, II-W Woods Hole	-	-	-	-	1	11	-	12	12 II-W
Mathematics, VIII	7	10	5	22	-	74	1	75	97 VIII
Mathematics with Computer Science, VIII-C	2	1	-	3	-	-	-	-	3 VIII-C
Physics, VIII	6	5	5	16	5	97	1	103	119VIII
Physics, VIII-A	1	-	1	2	-	-	-	-	2VIII-A
Total	19	26	18	63	11	336	2	349	412Total
WHITAKER COLLEGE of Health Sciences and Technology									
Harvard-MIT Division of Health Sciences and Technology, HST	-	-	-	-	4	51	4	59	59HST
Center for Advanced Educational Services, CAES	-	-	-	-	-	-	33	33	33CAES
Undesignated Sophomores	2	-	-	2	-	-	-	-	2UND
First Year	76	-	-	-	76	-	-	-	- 76First Year
Special Undergraduate -- No Course	-	-	-	2	-	-	-	-	2Special-NC
Grand Total	768	99	187	345	963	1,199	82	2,244	2,589Grand Total

NUMBER OF MINORITY* UNDERGRADUATES BY COURSE AND YEAR

October 5, 2001

FALL TERM 2001-2002 — OFFICE OF THE REGISTRAR

COURSE NAME	YEAR 2				YEAR 3				YEAR 4				TOTAL			
	Af	Na	Hi	As	Af	Na	Hi	As	Af	Na	Hi	As	Af	Na	Hi	As
SCHOOL OF ARCHITECTURE AND PLANNING																
Architecture, IV	-	-	3	6	1	1	4	1	-	-	4	7	1	1	11	14
Urban Studies and Planning, I	-	-	-	1	-	-	-	2	1	-	-	1	1	-	-	4
Total	-	-	3	7	1	1	4	3	1	-	4	8	2	1	11	18
SCHOOL OF ENGINEERING																
Aeronautics and Astronautics, VI																
Program 1 - Aeronautical Engineering, VI-1	4	-	7	5	5	4	10	6	2	2	6	6	11	6	23	17
Program 2 - Aeronautical Eng. with Information Technology, VI-2	1	1	2	1	-	-	1	-	-	-	3	2	1	1	6	3
Aeronautics and Astronautics, VI-C Internship	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-
Chemical Engineering,	7	-	5	14	13	-	4	16	9	-	7	22	29	-	16	52
Chemical Engineering, -C	-	-	-	1	-	-	-	-	-	-	-	2	-	-	-	3
Civil and Environmental Engineering, I-A	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Civil and Environmental Engineering, I-C	1	-	2	1	1	1	3	2	-	-	1	-	2	1	6	3
Civil and Environmental Engineering, I-E	-	-	2	2	1	1	-	1	-	-	2	1	1	1	4	4
Electrical Engineering and Computer Science, VI																
Program 1 - Electrical Science and Engineering	5	1	4	11	3	-	3	7	4	-	6	11	12	1	13	29
Program 2 - Electrical Engineering and Computer Science	17	1	30	71	20	3	21	50	10	4	20	58	47	8	71	179
Program 3 - Computer Science and Engineering	6	2	6	18	4	3	13	36	7	3	7	39	17	8	26	93
Electrical Engineering and Computer Science, VI-A Internship																
Program 1 - Electrical Science and Engineering	-	-	-	-	-	-	-	1	-	-	-	3	-	-	-	4
Program 2 - Electrical Engineering and Computer Science	-	-	-	-	-	-	1	5	-	-	1	7	-	-	2	12
Program 3 - Computer Science and Engineering	-	-	-	-	-	-	-	2	-	-	-	4	-	-	-	6
Materials Science and Engineering, III	-	1	3	4	-	-	1	1	1	-	1	5	1	1	5	10
Materials Science and Engineering, III-A	-	-	2	-	-	-	-	-	-	-	-	1	-	-	2	1
Materials Science and Engineering, III-B Internship	-	-	1	8	1	-	1	5	3	-	1	6	4	-	3	19
Mechanical Engineering, II	4	2	21	12	1	-	16	12	4	2	20	13	9	4	57	37
Mechanical Engineering, II-A	-	1	2	1	1	1	2	2	1	-	3	4	2	2	7	7
Mechanical Engineering, II-B Internship	-	-	-	-	1	-	1	-	-	-	1	1	1	-	2	1
Nuclear Engineering, II	-	-	-	-	-	1	-	-	-	-	3	1	-	1	3	1
Ocean Engineering, III	-	-	-	1	-	-	1	-	-	1	-	-	-	1	1	1
Total	45	9	87	150	51	14	78	146	41	12	83	187	137	35	248	483
SCHOOL OF HUMANITIES AND SOCIAL SCIENCE																
Economics, IV	-	-	1	4	1	-	2	11	1	1	2	13	2	1	5	28
History, I-H	-	-	-	-	-	1	-	-	-	-	-	1	-	1	-	1
Humanities and Engineering, I-E	-	-	-	-	-	-	-	-	2	-	-	1	2	-	-	1
Humanities and Science, I-S	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	2
Literature, I-L	-	-	1	-	-	-	-	1	-	-	1	1	-	-	2	2
Music and Theater Arts, I-M	-	-	1	-	-	-	-	-	-	-	-	1	-	-	1	1
Writing and Humanistic Studies, I-W	-	-	-	-	-	-	-	-	1	-	-	1	1	-	-	1
Linguistics and Philosophy, IV	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Political Science, VII	1	-	1	-	-	-	1	-	1	-	-	2	2	-	2	2

Total		2	-	4	4		1	1	3	12		5	1	3	22		8	2	10	38
SLOAN SCHOOL OF MANAGEMENT																				
Management, V		6	4	9	54		8	4	12	30		5	1	8	33		19	9	29	117
SCHOOL OF SCIENCE																				
Biology, VII		5	2	6	31		4	3	4	40		4	1	9	26		13	6	19	97
Biology, VII-A		-	-	-	-		-	-	-	4		-	-	-	1		-	-	-	5
Brain and Cognitive Sciences, I		2	-	5	13		1	2	3	10		2	-	3	8		5	2	11	31
Chemistry, V		-	1	2	14		-	1	3	10		2	-	-	11		2	2	5	35
Earth, Atmospheric, and Planetary Sciences, II		-	-	1	-		1	-	1	-		1	1	1	-		2	1	3	-
Mathematics, VIII		-	-	6	7		1	1	2	4		3	-	2	8		4	1	10	19
Mathematics with Computer Science, VIII-C		-	-	2	-		-	-	3	1		-	-	-	2		-	-	5	3
Physics, VIII		-	1	5	6		-	-	2	8		1	1	1	7		1	2	8	21
Physics, VIII-A		-	-	2	1		-	-	-	-		-	-	-	1		-	-	2	2
Total		7	4	29	72		7	7	18	77		13	3	16	64		27	14	63	213
Undesignated Sophomores		-	-	1	3		-	-	-	-		-	-	-	-		-	-	1	3
Special - No Course		-	-	-	-		-	-	-	-		-	-	-	-		1	-	-	-
	AfNa Hi As																			
First Year	62 25110301	-	-	-	-		-	-	-	-		-	-	-	-		62	25	110	301
Grand Total	62 25110301	60	17	13	32	90	68	27	11	52	68	65	17	11	43	14	256	86	47	21,173

_ Af African American, Na Native American, Hi Hispanic American, As Asian American.

NUMBER OF MINORITY_ GRADUATE STUDENTS BY COURSE AND YEAR

October 5, 2001

FALL TERM 2001-2002 — OFFICE OF THE REGISTRAR

COURSE NAME	MASTER ENG Af	Na	Hi	As	DOCTORAL _ Af	Na	Hi	As	SPECIAL Af	Na	Hi	As	TOTAL Af	Na	Hi	As
SCHOOL OF ARCHITECTURE AND PLANNING																
Architecture, IV	4	-	1	19	-	-	1	2	-	-	-	-	4	-	2	21
Urban Studies and Planning, I	9	-	7	9	5	-	2	1	-	-	-	-	14	-	9	10
Program in Media Arts and Sciences, MAS	-	-	-	8	1	-	3	2	-	-	-	-	1	-	3	10
Total	13	-	8	36	6	-	6	5	-	-	-	-	19	-	14	41
SCHOOL OF ENGINEERING																
Aeronautics and Astronautics, VI	4	-	7	12	-	-	-	3	-	-	-	-	4	-	7	15
Chemical Engineering,	1	-	1	5	3	1	2	8	-	-	-	-	4	1	3	13
Civil and Environmental Engineering, I	2	-	5	6	-	-	3	6	-	-	-	-	2	-	8	12
Civil and Environmental Engineering, I-W Woods Hole	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-
Electrical Engineering and Computer Science, VI	6	-	6	28	11	-	4	65	-	-	-	1	17	-	10	94
Electrical Engineering and Computer Science, VI-P M.Eng.	5	2	5	83	-	-	-	-	-	-	-	-	5	2	5	83
Electrical Eng and Computer Science, VI-PA M.Eng., Internship	-	1	-	4	-	-	-	-	-	-	-	-	-	1	-	4
Materials Science and Engineering, III	1	-	3	12	2	-	1	2	-	-	-	-	3	-	4	14
Mechanical Engineering, II	9	-	7	22	6	-	-	9	-	-	-	-	15	-	7	31
Nuclear Engineering, II	2	-	-	3	-	-	3	1	-	-	-	-	2	-	3	4
Ocean Engineering, III	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Naval Construction and Engineering, III-A	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-
Division of Bioengineering and Environmental Health, BEH	-	-	2	2	2	-	1	7	-	-	1	-	2	-	4	9
Engineering Systems Division, ESD	-	-	1	7	-	-	-	2	-	-	-	-	-	-	1	9
System Design and Management, SDM	-	-	-	3	-	-	-	-	-	-	-	1	-	-	-	4
Total	30	3	38	188	24	1	15	103	-	-	1	2	54	4	54	293
SCHOOL OF HUMANITIES, ARTS, AND SOCIAL SCIENCES																
Economics, IV	-	-	-	-	3	-	1	10	-	-	-	-	3	-	1	10
Linguistics and Philosophy, IV	-	-	-	-	1	-	1	2	-	-	-	-	1	-	1	2
Political Science, VII	-	-	-	-	-	-	1	5	-	-	-	-	-	-	1	5
Program in Comparative Media Studies, I-CMS	1	1	-	-	-	-	-	-	-	-	-	-	1	1	-	-
Total	1	1	-	-	4	-	3	17	-	-	-	-	5	1	3	17
SLOAN SCHOOL OF MANAGEMENT																
Management, V	23	3	20	97	1	-	2	3	-	-	-	-	24	3	22	100
Management Fellows, V-A	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Operations Research, OR	-	-	-	-	1	-	1	4	-	-	-	-	1	-	1	4
Total	23	3	20	98	2	-	3	7	-	-	-	-	25	3	23	105
SCHOOL OF SCIENCE																
Biology, VII	-	-	-	-	4	1	4	19	-	-	-	1	4	1	4	20
Biology, VII-W Woods Hole	-	-	-	-	1	-	-	1	-	-	-	-	1	-	-	1
Brain and Cognitive Sciences, I	-	-	-	-	1	-	-	4	-	-	-	-	1	-	-	4

Chemistry, V	1	-	-	-	6	1	5	12	-	-	-	-	7	1	5	12
Earth, Atmospheric, and Planetary Sciences, II	-	-	-	2	-	-	1	2	-	-	-	-	-	-	1	4
Earth, Atmospheric, and Planetary Sciences, II-W Woods Hole	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	3
Mathematics, VIII	-	-	-	-	-	-	1	4	-	-	-	1	-	-	1	5
Physics, VIII	-	-	-	-	3	1	3	12	-	-	-	-	3	1	3	12
Total	1	-	-	2	15	3	14	57	-	-	-	2	16	3	14	61
WHITAKER COLLEGE of Health Sciences and Technology																
Harvard-MIT Division of Health Sciences and Technology, HST	-	-	-	-	5	-	10	73	1	-	-	-	6	-	10	73
Center for Advanced Educational Services, CAES	-	-	-	-	-	-	-	-	1	-	1	1	1	-	1	1
Grand Total	68	7	66	324	56	4	51	262	2	-	2	5	126	11	119	591

_ Af African American, Na Native American, Hi Hispanic American, As Asian American

__ Includes Regular and Non-Resident students.

Appendix C: Faculty and Academic Staff Count

Department	Professors in Administration	Professor	Associate Professor with Tenure	Associate Professor without Tenure	Assistant Professor	***Subtotal - Tenure Track Faculty***	Adjunct Professor	Senior Research Associate	Senior Research Scientist	Senior Research Engineer	Professor (non-tenure)	Senior Lecturer	Lecturer	Instructor	Technical Instructor	Postdoctoral Associate	Postdoctoral Fellow	Research Fellow	Research Affiliate	Visiting Professor	Visiting Associate Professor	Visiting Assistant Professor	Visiting Lecturer	Visiting Scholar	Visiting Engineer	Visiting Scientist	Coach/Trainer	Other Academic Staff*	**GRAND TOTAL**	Teaching Assistant	Research Assistant	Instructor G	**Total**
CHAIRMAN OF THE CORPORATION	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	
SECRETARY OF THE CORPORATION	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	
Sub-total President's Office	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**0**	**0**	**0**	
CENTER FOR ADVANCED EDUCATIONA	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	4	0	0	8	0	0	0	
CHANCELLOR'S OFFICE	0	0	0	0	0	**0**	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	
DIBNER INSTITUTE	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	21	2	0	0	0	0	0	13	0	0	0	36	0	0	0	
INSTITUTE PROFESSORS	0	3	0	0	0	**3**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	13	0	0	0	
MCGOVERN INSTITUTE FOR BRAIN R	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	2	0	0	0	
OFFICE OF THE PROVOST	0	4	0	0	0	**4**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	10	0	5	0	1	21	0	0	0	
Sub-total Provost's Office	**0**	**7**	**0**	**0**	**0**	**7**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**21**	**2**	**1**	**0**	**0**	**0**	**1**	**27**	**1**	**9**	**0**	**12**	**82**	**0**	**0**	**0**	
ARCHITECTURE, DEPARTMENT OF	2	10	8	2	7	**29**	3	0	0	0	0	2	9	0	1	0	1	1	3	5	5	2	0	3	0	0	0	8	72	96	14	0	**110**
CENTER FOR ADVANCED VISUAL STU	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	3	9	0	0	0	0	1	0	1	0	0	14	0	0	0	**0**
CENTER FOR REAL ESTATE	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	**0**
MEDIA ARTS AND SCIENCES SECTIO	1	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**0**
MEDIA LABORATORY	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	5	0	11	0	1	30	0	0	0	**0**
PROGRAM IN MEDIA ARTS AND SCIE	1	4	5	6	6	**22**	1	0	2	0	0	1	4	0	0	3	0	0	1	1	0	2	0	1	0	1	0	0	39	0	145	0	**145**
SCHOOL OF ARCHITECTURE AND PLA	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	5	0	0	0	0	6	0	0	0	**0**
URBAN STUDIES & PLANNING, DEPA	3	12	3	0	7	**25**	3	0	0	0	4	5	10	0	0	1	1	18	0	1	1	1	2	12	0	0	0	2	86	13	17	0	**30**
Sub-total Sch of Arch & Plann	**7**	**26**	**16**	**8**	**20**	**77**	**7**	**0**	**2**	**0**	**4**	**8**	**23**	**0**	**1**	**4**	**3**	**22**	**26**	**7**	**6**	**5**	**2**	**28**	**0**	**13**	**0**	**11**	**249**	**109**	**176**	**0**	**285**
AERONAUTICS AND ASTRONAUTICS,	2	16	4	4	8	**34**	2	0	0	2	5	11	15	0	2	6	0	0	16	1	1	1	0	0	0	0	0	4	100	14	169		**183**
ARCHAEOLOGY, DEPARTMENT OF	0	2	0	0	0	**2**	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	**0**
ARTIFICIAL INTELLIGENCE LABORA	0	0	0	0	0	**0**	0	0	1	0	0	0	0	0	0	10	0	0	13	0	0	0	0	0	0	4	0	1	29	0	0	0	**0**
BIOTECHNOLOGY PROCESS ENGINEER	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	3	1	0	1	0	0	0	0	1	0	0	0	0	6	0	0	0	**0**
CENTER FOR INNOVATION IN PRODU	0	0	0	0	0	**0**	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	5	0	0	0	**0**
CENTER FOR TECHNOLOGY, POLICY,	0	0	0	0	0	**0**	0	0	1	1	0	0	0	0	0	2	0	0	6	0	0	0	0	6	0	1	0	0	17	0	0	0	**0**
CENTER FOR TRANSPORTATION STUD	0	0	0	0	0	**0**	0	0	0	0	0	1	1	0	0	1	0	1	5	0	0	0	0	0	0	6	0	1	16	0	0	0	**0**
CHEMICAL ENGINEERING, DEPARTME	4	19	4	2	4	**33**	0	0	0	0	1	4	2	1	0	43	9	0	24	0	0	0	1	1	3	6	0	5	133	25	163		**188**
CIVIL AND ENVIRONMENTAL ENGINE	5	18	4	5	6	**38**	0	1	0	1	0	2	9	0	0	9	10	0	10	0	0	0	0	4	3	2	0	6	95	35	123	1	**159**
DIVISION OF BIOENGINEERING & E	2	2	3	0	2	**9**	0	0	1	0	0	0	1	0	0	25	12	1	4	0	0	0	2	2	0	1	0	1	59	7	35		**42**
ELECTRICAL ENGINEERING & COMPU	12	61	15	9	15	**112**	3	0	0	1	3	10	12	3	6	4	0	0	5	1	1	0	0	0	0	0	0	8	169	123	594		**717**
ENGINEERING SYSTEMS DIVISION	0	0	0	0	0	**0**	2	0	0	0	0	3	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	7	0	0	0	**0**
INDUSTRIAL PERFORMANCE CENTER	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**0**
INTEGRATED STUDIES PROGRAM	0	0	0	0	0	**0**	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**0**
LAB FOR ELECTROMAGNETIC & ELEC	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	2	0	0	7	0	0	0	**0**
LAB FOR MANUFACTURING & PRODUC	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	3	2	1	0	1	8	0	0	0	**0**
LABORATORY FOR COMPUTER SCIENC	1	0	0	0	0	**1**	0	0	2	0	0	0	0	0	0	6	0	0	12	0	0	0	0	3	2	13	0	1	40	0	0	0	**0**
LABORATORY FOR INFORMATION AND	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	7	0	0	7	0	0	0	0	0	0	3	0	0	17	0	0	0	**0**
LEADERS FOR MANUFACTURING PROG	0	0	0	0	0	**0**	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**0**
MATERIALS PROCESSING CENTER	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	7	9	0	0	2	0	0	0	0	0	0	6	0	0	24	0	0	0	**0**
MATERIALS SCIENCE AND ENGINEER	4	18	3	0	5	**30**	0	1	0	0	7	3	4	0	4	25	3	0	11	3	0	0	0	3	1	9	0	0	104	11	138		**149**
MECHANICAL ENGINEERING, DEPART	4	33	7	5	5	**54**	3	0	1	0	16	8	19	0	4	27	0	0	4	1	2	0	0	8	3	5	0	0	155	31	235		**266**
MICROSYSTEMS TECHNOLOGY LABORA	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	3	1	0	0	1	0	0	0	0	0	6	0	0	11	0	0	0	**0**

Department	Professors in Administration	Professor	Associate Professor with Tenure	Associate Professor without Tenure	Assistant Professor	***Subtotal - Tenure Track Faculty***	Adjunct Professor	Senior Research Associate	Senior Research Scientist	Senior Research Engineer	Professor (non-tenure)	Senior Lecturer	Lecturer	Instructor	Technical Instructor	Postdoctoral Associate	Postdoctoral Fellow	Research Fellow	Research Affiliate	Visiting Professor	Visiting Associate Professor	Visiting Assistant Professor	Visiting Lecturer	Visiting Scholar	Visiting Engineer	Visiting Scientist	Coach/Trainer	Other Academic Staff**	**GRAND TOTAL**	Teaching Assistant	Research Assistant	Instructor G	**Total**
NUCLEAR ENGINEERING, DEPARTMEN	1	11	2	2	0	**16**	1	0	1	0	1	1	1	0	0	3	2	0	15	1	0	0	0	0	3	3	0	1	49	11	76		**87**
OCEAN ENGINEERING, DEPARTMENT	2	9	0	2	0	**13**	1	0	0	0	2	4	6	0	0	5	1	0	7	1	0	0	0	0	0	0	0	5	45	7	34		**41**
PROJECT I-CAMPUS	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	**0**
SCHOOL OF ENGINEERING	0	2	0	0	0	**2**	0	0	0	0	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	8	57		**65**
SYSTEM DESIGN AND MANAGEMENT P	0	0	0	0	0	**0**	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**0**
TECHNOLOGY AND POLICY PROGRAM	0	0	0	0	0	**0**	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**0**
Sub-total Sch of Engineering	**37**	**191**	**42**	**29**	**45**	**344**	**12**	**2**	**7**	**5**	**36**	**52**	**74**	**4**	**24**	**189**	**40**	**2**	**148**	**9**	**4**	**1**	**3**	**34**	**18**	**69**	**0**	**34**	**1111**	**272**	**1624**	**1**	**1897**
ANTHROPOLOGY PROGRAM	1	4	1	0	1	**7**	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0	0	3	0	0	0	0	15	0	0	0	**0**
CENTER FOR INTERNATIONAL STUDI	0	0	0	0	0	**0**	0	0	0	0	0	0	1	0	0	0	0	7	9	0	0	0	0	12	0	0	0	1	30	0	0	0	**0**
ECONOMICS, DEPARTMENT OF	1	19	1	1	9	**31**	0	0	0	0	0	1	0	1	0	1	0	0	0	8	1	0	0	9	0	0	0	1	53	22	9	8	**39**
FOREIGN LANGUAGES & LITERATURE	1	4	1	1	1	**8**	0	0	0	0	0	4	21	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	35	0	0	0	**0**
HISTORY SECTION	2	4	3	2	3	**14**	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	**0**
LINGUISTICS AND PHILOSOPHY, DE	1	10	2	5	3	**21**	0	0	0	0	2	0	0	0	0	1	0	0	1	4	0	0	0	22	0	0	0	0	51	12	14	0	**26**
LITERATURE SECTION	1	7	3	2	2	**15**	0	0	0	0	0	0	6	0	0	0	0	0	2	0	0	0	0	6	0	0	0	0	29	0	0	0	**0**
MUSIC AND THEATER ARTS SECTION	2	4	1	2	2	**11**	0	0	0	0	1	6	11	0	3	0	0	0	0	0	0	0	0	3	0	0	0	8	43	0	0	0	**0**
POLITICAL SCIENCE, DEPARTMENT	1	9	4	4	6	**24**	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	5	0	0	0	0	32	25	22	0	**47**
PROGRAM IN SCIENCE, TECHNOLOGY	1	6	2	1	2	**12**	0	0	0	0	0	1	0	0	0	1	1	10	0	2	0	0	0	13	0	0	0	0	40	2	6	0	**8**
PROGRAM IN WRITING AND HUMANIS	2	3	0	1	0	**6**	2	0	0	0	0	1	20	1	20	0	0	0	2	0	0	0	0	0	0	0	0	0	52	0	0	0	**0**
SCHOOL OF HUMANITIES, ARTS AND	0	0	0	0	0	**0**	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0	19	0	**19**
Sub-total Sch of Humanities	**13**	**70**	**18**	**19**	**29**	**149**	**2**	**0**	**0**	**0**	**3**	**13**	**67**	**4**	**23**	**4**	**2**	**17**	**15**	**14**	**2**	**0**	**0**	**74**	**0**	**0**	**0**	**10**	**399**	**61**	**51**	**8**	**120**
SLOAN SCHOOL OF MANAGEMENT	3	50	3	6	34	**96**	1	0	4	0	3	20	3	0	0	5	0	0	3	6	6	6	3	26	0	2	0	3	187	114	56	0	**170**
Sub-total Sch of Management	**3**	**50**	**3**	**6**	**34**	**96**	**1**	**0**	**4**	**0**	**3**	**20**	**3**	**0**	**0**	**5**	**0**	**0**	**3**	**6**	**6**	**6**	**3**	**26**	**0**	**2**	**0**	**3**	**187**	**114**	**56**	**0**	**170**
BIOLOGY, DEPARTMENT OF	4	30	7	3	6	**50**	0	0	0	0	6	0	0	0	4	53	39	1	45	0	0	0	0	13	0	17	0	4	232	0	60	0	**60**
BRAIN AND COGNITIVE SCIENCES,	2	13	3	2	6	**26**	0	0	0	0	3	0	3	0	2	14	15	0	21	1	1	0	3	0	0	5	0	0	94	20	6	0	**26**
CENTER FOR CANCER RESEARCH	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	23	21	0	22	0	0	0	0	2	0	5	0	2	75	0	0	0	**0**
CENTER FOR LEARNING AND MEMORY	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	19	14	0	17	0	0	0	0	3	0	0	0	3	56	0	0	0	**0**
CENTER FOR SPACE RESEARCH	0	0	0	0	0	**0**	0	0	2	0	0	0	0	0	0	18	4	0	5	0	0	0	0	0	0	1	0	0	30	0	0	0	**0**
CHEMISTRY, DEPARTMENT OF	3	18	0	1	6	**28**	0	0	0	0	3	0	0	0	1	37	30	0	5	1	0	0	0	8	1	4	0	5	123	51	164	0	**215**
EARTH, ATMOSPHERIC, & PLANETAR	1	29	0	2	3	**35**	1	0	0	0	4	1	1	0	0	30	14	1	12	3	2	0	0	2	0	18	0	3	127	15	56	0	**71**
EXPERIMENTAL STUDY GROUP	0	0	0	0	0	**0**	0	0	0	0	0	2	6	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	10	0	0	0	**0**
LABORATORY FOR NUCLEAR SCIENCE	0	0	0	0	0	**0**	0	0	3	0	0	0	0	0	0	10	1	0	4	0	0	0	0	0	0	25	0	10	53	0	0	0	**0**
MATHEMATICS, DEPARTMENT OF	1	32	4	1	14	**52**	0	0	0	0	0	1	1	28	0	0	6	0	10	3	0	1	0	14	0	1	0	1	118	68	13	0	**81**
PHYSICS, DEPARTMENT OF	8	39	4	2	15	**68**	0	0	6	0	2	2	0	0	5	6	15	0	0	6	0	0	0	0	0	7	0	27	144	36	159	0	**195**
SCHOOL OF SCIENCE	0	1	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	**0**
SPECTROSCOPY LABORATORY	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	25	0	0	27	0	0	0	**0**
Sub-total Sch of Science	**19**	**162**	**18**	**11**	**50**	**260**	**1**	**0**	**11**	**0**	**18**	**6**	**11**	**28**	**12**	**211**	**159**	**2**	**141**	**14**	**3**	**1**	**3**	**44**	**1**	**109**	**0**	**56**	**1091**	**190**	**458**	**0**	**648**
TREASURER'S OFFICE	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	**0**
Sub-total Treasurer's Office	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**				

Department	Professors in Administration	Professor	Associate Professor with Tenure	Associate Professor without Tenure	Assistant Professor	***Subtotal - Tenure Track Faculty***	Adjunct Professor	Senior Research Associate	Senior Research Scientist	Senior Research Engineer	Professor (non-tenure)	Senior Lecturer	Lecturer	Instructor	Technical Instructor	Postdoctoral Associate	Postdoctoral Fellow	Research Fellow	Research Affiliate	Visiting Professor	Visiting Associate Professor	Visiting Assistant Professor	Visiting Lecturer	Visiting Scholar	Visiting Engineer	Visiting Scientist	Coach/Trainer	Other Academic Staff*	**GRAND TOTAL**	Teaching Assistant	Research Assistant	Instructor G	**Total**
MEDICAL DEPARTMENT	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120	120	0	0	0	**0**
VICE PRESIDENT FOR HUMAN RESOU	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	**0**
Sub-total VP for HR	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**121**	**121**	**0**	**0**	**0**	**0**
CENTER FOR BIOMEDICAL ENGINEER	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	1	2	0	0	8	0	0	0	**0**
CENTER FOR ENVIRONMENTAL HEALT	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	7	0	0	11	0	0	0	**0**
CENTER FOR MATERIALS SCIENCE A	1	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1	0	0	5	0	0	0	**0**
CLINICAL RESEARCH CENTER	0	0	0	0	0	**0**	0	0	0	0	1	0	0	0	0	1	10	0	37	0	0	0	0	1	0	35	0	4	89	0	0	0	**0**
DIVISION OF COMPARATIVE MEDICI	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	3	5	0	3	0	0	0	0	0	0	9	0	7	27	0	0	0	**0**
FRANCIS BITTER MAGNET LABORATO	0	0	0	0	0	**0**	0	0	1	0	0	0	0	0	0	9	5	0	0	0	0	0	0	0	0	12	0	0	27	0	0	0	**0**
HAYSTACK OBSERVATORY	0	0	0	0	0	**0**	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	**0**
HRVD-MIT DIVISION OF HEALTH SC	0	5	0	0	1	**6**	0	0	2	0	1	0	6	0	0	11	8	1	45	3	0	0	1	14	0	18	0	99	215	16	94	1	**111**
LABORATORY FOR ENERGY AND THE	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	3	2	0	3	0	0	0	0	8	3	4	0	0	23	0	0	0	**0**
NUCLEAR REACTOR LABORATORY	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	9	0	1	17	0	0	0	**0**
OPERATIONS RESEARCH CENTER	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	31	0	**32**
PLASMA SCIENCE AND FUSION CENT	0	0	0	0	0	**0**	0	0	6	1	0	1	0	0	0	3	0	0	14	0	0	0	0	1	0	38	0	0	64	0	0	0	**0**
RESEARCH LABORATORY OF ELECTRO	0	0	0	0	0	**0**	0	0	1	0	0	1	0	0	0	27	6	0	63	0	0	0	0	0	0	29	0	0	127	0	0	0	**0**
SEA GRANT COLLEGE PROGRAM	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	3	0	0	0	**0**
TECHNOLOGY AND DEVELOPMENT PRO	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1	0	0	4	0	0	0	**0**
WHITAKER COLLEGE OF HEALTH SCI	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**0**
Sub-total Vp Research	**1**	**5**	**0**	**0**	**1**	**7**	**0**	**0**	**11**	**1**	**2**	**2**	**6**	**0**	**0**	**64**	**36**	**2**	**183**	**3**	**0**	**0**	**1**	**24**	**5**	**165**	**0**	**111**	**623**	**17**	**125**	**1**	**143**
AIR FORCE AEROSPACE STUDIES	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	5	0	0	0	0	1	0	0	0	0	0	0	0	0	6	0	0	0	**0**
MILITARY SCIENCE	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	4	0	0	0	0	1	0	0	0	0	0	0	0	1	6	0	0	0	**0**
NAVAL SCIENCE	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	10	0	0	0	0	1	0	0	0	0	0	0	0	0	11	0	0	0	**0**
Sub-total Dean Undergrad	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**19**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**23**	**0**	**0**	**0**	**0**
OFFICE OF THE VICE PRESIDENT O	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	**0**
Sub-total VP Res Dev	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**				
ATHLETIC DEPARTMENT	0	0	4	4	8	**16**	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	20	2	44	0	0	0	**0**
CAMPUS ACTIVITIES COMPLEX	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	**0**
DEAN FOR STUDENT LIFE	0	0	1	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**0**
Sub-total Dean Student Life	**0**	**0**	**5**	**4**	**8**	**17**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**20**	**2**	**49**	**0**	**0**	**0**	**0**
ADMINISTRATION	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	9	0	0	0	**0**
Sub-total Administration	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**9**	**9**	**0**	**0**	**0**	**0**
FINAL TOTALS	**80**	**511**	**102**	**77**	**187**	**957**	**23**	**2**	**35**	**6**	**67**	**101**	**184**	**42**	**83**	**477**	**261**	**47**	**517**	**56**	**21**	**13**	**13**	**257**	**25**	**367**	**20**	**374**	**3948**	**763**	**2519**	**10**	**3292**

Personnel Changes

Corporation

Changes of Appointment

George N. Hatsopoulos
Life Member, Emeritus

Charles H. Spaulding
Life Member, Emeritus

Mary Frances Wagley
Life Member, Emeritus

Elections

Mark R. Epstein
Member

Paul J. Ferri
Member

Jennifer A. Frank
Member

Norman E. Gaut
Member

Arthur Gelb
Life Member

L. Robert Johnson
Member

Ronald A. Kurtz
Life Member

Jorge E. Rodriguez
Member

James H. Simons
Member

Alan G. Spoon
Member

Theresa M. Stone
Member

Susan E. Whitehead
Member

Robert E. Wilhelm
Member

Member Ex-Officio

James A. Lash
President, Association of Alumni and Alumnae

Term Expired

Gregory K. Arenson
Member

Osie V. Combs, Jr.
Member

Lissa A. Martinez
Member

Elisabeth A. Stock
Member

Faculty

Deaths

Michael L. Dertouzos
Professor/Director
Laboratory for Computer Science

Peter Elias
Professor
Department of Electrical Engineering and Computer Science

David M. Epstein
Professor
Music and Theater Arts Section

Alfred A. H. Keil
Professor
School of Engineering

Gyorgy Kepes
Professor
Department of Architecture

Patrick Leehey
Professor
Department of Mechanical Engineering

Lawrence M. Lidsky
Professor
Department of Nuclear Engineering

Pasquale E. Melaragno
Assistant Professor
Athletic Department

Henry M. Paynter
Professor
Department of Mechanical Engineering

Victor F. Weisskopf
Institute Professor

Institute Professors

Retirements

Aron M. Bernstein
Professor
Department of Physics

Louis L. Bucciarelli, Jr.
Professor
School of Engineering

Noam A. Chomsky
Professor
Institute Professors

Harvey P. Greenspan
Professor
Department of Mathematics

Frederick C. Hennie, III
Professor
Department of Electrical Engineering and Computer Science

Edward D. Levine
Professor
Department of Architecture

Frederick J. McGarry
Professor
Professional Institute

Lawrence E. Rosenson
Professor
Department of Physics

Michael S. Scott Morton
Professor
Sloan School of Management

Stephen D. Senturia
Professor
Department of Electrical Engineering and Computer Science

Arthur C. Smith
Professor
Department of Electrical Engineering and Computer Science

Rainer R. Weiss
Professor
Department of Physics

August F. Witt
Professor
Department of Materials Science and Engineering

Resignations

Professor

Carl O. Pabo
Professor
Department of Biology

Lisa J. Randall
Professor
Department of Physics

Lawrence M. Wein
Professor
Sloan School of Management

Associate Professor

Brenda L. Cotto-Escalera
Associate Professor
Music and Theater Arts Section

Julie Dorsey
Associate Professor
Department of Electrical Engineering and Computer Science

Heather C. Richardson
Associate Professor
History Section

Kai-Yeung Siu
Associate Professor
Department of Mechanical Engineering

Sarah Slaughter
Associate Professor
Department of Civil and Environmental Engineering

David M. Spector
Associate Professor
Department of Economics

Vahid Tarokh
Associate Professor
Department of Electrical Engineering and Computer Science

Nader Tavassoli
Associate Professor
Sloan School of Management

Ralph Nicholas Wedgwood
Associate Professor
Department of Linguistics and Philosophy

Assistant Professor

Brandice J. Canes-Wrone
Assistant Professor
Department of Political Science

Lucia Caporaso
Assistant Professor
Department of Mathematics

Ely Dahan
Assistant Professor
Sloan School of Management

Peter J. Davis
Assistant Professor
Sloan School of Management

Mary Ellen McLaughlin

Assistant Professor
Athletic Department

Jowell Sabino
Assistant Professor
Sloan School of Management

Sylvia L. Sanders
Assistant Professor
Department of Biology

Joshua D. Sosin
Assistant Professor
History Section

Andras S. Szenes
Assistant Professor
Department of Mathematics

Jonathan R Zatlin
Assistant Professor
History Section

Promotions

To Professor

Erik Brynjolfsson
George and Sandi Schussel Professor
Sloan School of Management

Jung-Hoon Chun
Professor
Department of Mechanical Engineering

David G. Cory
Professor
Department of Nuclear Engineering

Peter H. Fisher
Professor
Department of Physics

Sabine Iatridou
Professor
Department of Linguistics and Philosophy

M. Frans Kaashoek
Professor
Department of Electrical Engineering and Computer Science

Nancy Kanwisher
Professor
Department of Brain and Cognitive Sciences

Anne M. Mayes
Professor
Department of Materials Science and Engineering

Gareth H. McKinley

Professor
Department of Mechanical Engineering

Wanda J. Orlikowski
Professor
Sloan School of Management

Ian A. Waitz
Professor
Department of Aeronautics and Astronautics

Stephen Yablo
Professor
Department of Linguistics and Philosophy

Jackie Yi-Ru Ying
Professor
Department of Chemical Engineering

To Associate Professor

Saman P. Amarasinghe
Associate Professor
Department of Electrical Engineering and Computer Science

Dan Ariely
Associate Professor
Sloan School of Management

Bruce M. Blumberg
Associate Professor
Program in Media Arts and Sciences

Carlos E. S. Cesnik
Associate Professor
Department of Aeronautics and Astronautics

Andrew Chess
Associate Professor
Department of Biology

David Cochran
Associate Professor
Department of Mechanical Engineering

Kenneth R. Czerwinski
Associate Professor
Department of Nuclear Engineering

Thomas F. DeFrantz
Associate Professor
Music and Theater Arts Section

Frank Gertler
Associate Professor
Department of Biology

George Haller
Associate Professor
Department of Mechanical Engineering

Lars Hesselholt
Associate Professor
Department of Mathematics

Christina Klein
Associate Professor
Literature Section

Helen Elaine Lee
Associate Professor
Program in Writing and Humanistic Studies

Guosong Liu
Associate Professor
Department of Brain and Cognitive Sciences

Leonard McMillan
Associate Professor
Department of Electrical Engineering and Computer Science

Krishna Rajagopal
Associate Professor
Department of Physics

Frederic Rasio
Associate Professor
Department of Physics

Harald J. Schwalbe
Associate Professor
Department of Chemistry

Washington Taylor, IV
Associate Professor
Department of Physics

Bruce Tidor
Associate Professor
Department of Electrical Engineering and Computer Science

Dimitrios Vayanos
Associate Professor
Sloan School of Management

To Assistant Professor

Cynthia L. Breazeal
LG Career Development Professor in Media Arts and Science Program in Media Arts and Sciences

Zoltan S. Spakovszky
Sorderberg Career Development Assistant Professor of Aeronautics and Astronautics
Department of Aeronautics and Astronautics

Changes of Appointments

Rohan Abeyaratne
Quentin Berg Professor
Department of Mechanical Engineering

H. Harry Asada
Ford Professor
Department of Mechanical Engineering

Krste Asanovic
Jamieson Career Development Assistant Professor
Department of Electrical Engineering and Computer Science

Howard Brenner
Henry Dow Professor
Department of Chemical Engineering

Rodney A. Brooks
Fujitsu Professor of Computer Science and Engineering
Artificial Intelligence Laboratory

Stephen L. Buchwald
Camille Dreyfus Professor
Department of Chemistry

M. Diane Burton
Michael M. Koerner (1949) Career Development
Sloan School of Management

Chris Csikszentmihaly
Fukutake Career Development Professor of Media Science
Program In Media Arts and Sciences

Esther Duflo
Castle Krob Career Development Assistant Professor of Economics
Department of Economics

Thomas W. Eagar
Thomas Lord Professor in Materials Science and Engineering
Department of Materials Science and Engineering

Elfatih A. B. Eltahir
H. M. King Bhumipol Professor
Department of Civil and Environmental Engineering

Alan H. Epstein
Richard Cockburn MacLaurin Professor of Aeronautics and Astronautics
Department of Aeronautics and Astronautics

Roberto Fernandez
William F. Pounds Professorship
Sloan School of Management

Kristin J. Forbes
Mitsubishi Career Development
Sloan School of Management

Lorna J. Gibson
Matoula Stavros Salapatas Professorship
Department of Materials Science and Engineering

William H. Green, Jr.
Texaco-Mangelsdorf Career Development Professor
Department of Chemical Engineering

Benjamin N. Grosof
Douglas Drane Career Development
Sloan School of Management

John P. Grotzinger
Robert R. Shrock Professor of E. A. P. S. and Professor of Geology
Department of Earth, Atmospheric, and Planetary Sciences

Nicolas Hadjiconstantinou
Rockwell International Career Development Assistant Professor
Department of Mechanical Engineering

Paula T. Hammond
Joseph R. Mares Career Development Chair
Department of Chemical Engineering

Wesley L. Harris
Charles Stark Draper Professor of Aeronautics and Astronautics
Department of Aeronautics and Astronautics

Ian Hunter
Hatsopoulos Professor
Department of Mechanical Engineering

Darrell J. Irvine
Van Tassel Assistant Professor of Bioengineering and Materials Science
Department of Materials Science and Engineering

Tyler E. Jacks
Director of the Center for Cancer Research and David H. Koch Professor
Center for Cancer Research

Sang-Gook Kim
Esther and Harold E. Edgerton Professor
Department of Mechanical Engineering

Lionel C. Kimerling
Thomas Lord Professor of Materials Science and Engineering
Materials Processing Center

Jonathan W. Lewellen
Jon D. Grubr, 1964 EE, 1966 GM Career Development
Sloan School of Management

Barbara H. Liskov
Ford Professor of Engineering
Department of Electrical Engineering and Computer Science

Tomas Lozano-Perez
Cecil H. Green Professor of Computer Science and Engineering
Department of Electrical Engineering and Computer Science

Nancy A. Lynch
NEC Professor of Software Engineering
Department of Electrical Engineering and Computer Science

John Maeda
Sony Corporation Career Development Professor of Media Arts and Science
Program In Media Arts and Sciences

Scott R. Manalis
NEC Career Development Professor of Media Arts and Sciences
Program In Media Arts and Sciences

Chiang C. Mei
The Donald and Martha Harleman Professor
Department of Civil and Environmental Engineering

Fiona E. Murray
Michael M. Koerner (1949) Career Development
Sloan School of Management

Amedeo R. Odoni
T. Wilson Professor of Aeronautics and Astronautics
Department of Aeronautics and Astronautics

Alan V. Oppenheim
Ford Professor of Engineering
Department of Electrical Engineering and Computer Science

Paul Osterman
NTU Career Development Professor
Sloan School of Management

Jun Pan
Zenen Zannetos Career Development Assistant Professor
Sloan School of Management

Anna Pavlova
Ford Foundation International Career Development
Sloan School of Management

Martin F. Polz
Gilbert T. Winslow Career Developing Chair
Department of Civil and Environmental Engineering

Ronald F. Probstein
Ford Professor of Engineering Emeritus
Department of Mechanical Engineering

Raul A. Radovitzky
Charles Stark Draper Assistant Professor of Aeronautics and Astronautics
Department of Aeronautics and Astronautics

Rajeev J. Ram
ITT Career Development Associate Professor
Department of Electrical Engineering and Computer Science

Michael F. Rubner
TDK Professor of Materials Science and Engineering
Center for Materials Science and Engineering

Antoinette Schoar
Maurice F. Strong Fund Career Development Assistant Professor
Sloan School of Management

Andreas S. Schulz
Class of 1958 Career Development Associate Professor
Sloan School of Management

Warren P. Seering
Weber-Shaghness Professor
Department of Mechanical Engineering

Thomas B. Sheridan
Ford Professor of Engineering, Emeritus
Department of Mechanical Engineering

James M. Snyder, Jr.
Arthur and Ruth Sloan Professor in Political Science
Department of Political Science

Gregory Stephanopoulos
Bayer Professor
Department of Chemical Engineering

Subra Suresh
Richard P. Simmons Professor of Materials Science and Engineering
Department of Materials Science and Engineering

Gerald J. Sussman
Matsushita Professor of Electrical Engineering
Department of Electrical Engineering and Computer Science

Joseph M. Sussman
J. R. East Professor
Department of Civil and Environmental Engineering

Seth Teller
X-Consortium Associate Professor of Computer Science Engineering
Department of Electrical Engineering and Computer Science

Edwin L. Thomas
Morris Cohen Professor of Materials Science and Engineering
Department of Materials Science and Engineering

Bernhardt L. Trout
Henry and Grace Doherty Professor
Department of Chemical Engineering

Sherry R. Turkle
Abby Rockfeller Mauze Professor of Social Studies and Technology
Program in Science, Technology, and Society

Karen E. Willcox
Charles Stark Draper Assistant Professor of Aeronautics and Astronautics
Department of Aeronautics and Astronautics

James H. Williams, Jr.
School of Engineering Process in Teaching Excellence
Department of Mechanical Engineering

New Appointments

Alice Petry Gast
Vice President for Research and Associate Provost
Office of the Provost

Professor

Susan Lindquist
Professor
Department of Biology

Jing Wang
Professor
Foreign Languages and Literatures Section

Associate Professor

Gang Chen
Associate Professor
Department of Mechanical Engineering

Diane E. Davis
Associate Professor
Department of Urban Studies and Planning

William T. Freeman
Associate Professor
Department of Electrical Engineering and Computer Science

Franz X. Kaertner
Associate Professor
Department of Electrical Engineering and Computer Science

Roger Petersen
Associate Professor
Department of Political Science

Roger E. Summons
Associate Professor
Department of Earth, Atmospheric, and Planetary Sciences

Assistant Professor

Marc A. Baldo
Assistant Professor
Department of Electrical Engineering and Computer Science

Lera Boroditsky
Assistant Professor
Department of Brain and Cognitive Sciences

Scott M. Burles
Assistant Professor
Department of Physics

Christopher Csikszentmihalyi
Assistant Professor
Program in Media Arts and Sciences

Jared R. Curhan
Assistant Professor
Sloan School of Management

Olivier L. de Weck
Assistant Professor
Department of Aeronautics and Astronautics

Jeremie Gallien
Assistant Professor
Sloan School of Management

Lorlene M. Hoyt
Assistant Professor
Department of Urban Studies and Planning

Darrell J. Irvine
Assistant Professor
Department of Materials Science and Engineering

Noel Jackson
Assistant Professor
Literature Section

Jin Gyo Kim
Assistant Professor
Sloan School of Management

Leonid Kogan
Assistant Professor
Sloan School of Management

Young S. Lee
Assistant Professor
Department of Physics

Nicola Marzari
Assistant Professor
Department of Materials Science and Engineering

David L. McAdams
Assistant Professor
Sloan School of Management

Leonid A Mirny
Assistant Professor
Harvard-MIT Division of Health Sciences and Technology

Ruaidhri M. O'Connor
Assistant Professor
Department of Civil and Environmental Engineering

Michael H. Perrott
Assistant Professor
Department of Electrical Engineering and Computer Science

Jovan Popovic
Assistant Professor
Department of Electrical Engineering and Computer Science

Alexander Postnikov
Assistant Professor
Department of Mathematics

Raul A. Radovitzky
Assistant Professor
Department of Aeronautics and Astronautics

Joseph P. Sadighi
Assistant Professor
Department of Chemistry

Anjali Sastry
Assistant Professor
Sloan School of Management

Simona Socrate
Assistant Professor
Department of Mechanical Engineering

Patricia Tang
Assistant Professor
Music and Theater Arts Section

Joshua Brett Tenenbaum
Assistant Professor
Department of Brain and Cognitive Sciences

Eric J. Van den Steen
Assistant Professor
Sloan School of Management

Heghnar Watenpaugh
Assistant Professor
Department of Architecture

Michele Williams
Assistant Professor
Sloan School of Management

Peter Wysocki
Assistant Professor
Sloan School of Management

J. Meejin Yoon
Assistant Professor
Department of Architecture

Jonathan R. Zatlin
Assistant Professor
History Section

Visiting Professor

Dan Abramovich
Visiting Professor
Department of Mathematics

Edith K. E. Ackermann
Visiting Professor
Department of Architecture

Martin J. Andler
Visiting Professor
Department of Mathematics

Piero Baglioni
Visiting Professor
Department of Nuclear Engineering

Kaushik Basu
Visiting Professor
Department of Economics

Mark Duggan
Visiting Professor
Department of Economics

Espen Eckbo
Visiting Professor
Sloan School of Management

Richard Feldman
Visiting Professor
Department of Linguistics and Philosophy

Michael Fu
Visiting Professor
Sloan School of Management

John S. Gero
Visiting Professor
Department of Architecture

David A. Guenther
Visiting Professor
Sloan School of Management

Allen C. Haggerty
Visiting Professor
Department of Aeronautics and Astronautics

Eli Hirsch
Visiting Professor
Department of Linguistics and Philosophy

Eva Hoffman
Visiting Professor
Foreign Languages and Literatures Section

Clifford Holderness
Visiting Professor
Sloan School of Management

John D. Idoine
Visiting Professor
Department of Nuclear Engineering

George E. M. Karniadakis
Visiting Professor
Department of Ocean Engineering

Ephraim Kleiman
Visiting Professor
Department of Economics

Jasper Knoester
Visiting Professor
Department of Chemistry

Utpal Lahiri
Visiting Professor
Department of Linguistics and Philosophy

Frederick K. Lamb
Visiting Professor
Department of Physics

Jean E. Lannes
Visiting Professor
Department of Mathematics

Susan Lederman
Visiting Professor
Department of Mechanical Engineering

Mary Maher
Visiting Professor
Department of Architecture

Shlomo Maital
Visiting Professor
Sloan School of Management

Perry Mehrling
Visiting Professor
Sloan School of Management

Paul Milgrom
Visiting Professor
Department of Economics

David E. Moncton
Visiting Professor
Department of Physics

Theodore D. Moustakas
Visiting Professor
Department of Materials Science and Engineering

Sekazi Mtingwa
Visiting Professor
Department of Physics

Antonio Muntadas
Visiting Professor
Department of Architecture

Ichiya Nakamura
Visiting Professor
Program in Media Arts and Sciences

James F. O'Gorman
Visiting Professor
Department of Architecture

Paul M. Rojko
Visiting Professor
Air Force Aerospace Studies

Donca Steriade
Visiting Professor
Department of Linguistics and Philosophy

Brian Subirana
Visiting Professor
Sloan School of Management

Juan Domingo Tardos
Visiting Professor
Department of Ocean Engineering

John Vande Vate
Visiting Professor
Sloan School of Management

Shimon Vega
Visiting Professor
Department of Chemistry

Kie Zuraw
Visiting Professor
Department of Linguistics and Philosophy

Visiting Associate Professor

Jae-Ho An
Visiting Associate Professor
Department of Earth, Atmospheric, and Planetary Sciences

Robert A. Batey
Visiting Associate Professor
Department of Chemistry

Marlon Blackwell
Visiting Associate Professor
Department of Architecture

Carol Burns
Visiting Associate Professor
Department of Architecture

Wayne Guay
Visiting Associate Professor
Sloan School of Management

Robert E. Haywood
Visiting Associate Professor
Department of Architecture

Brian Healy
Visiting Associate Professor
Department of Architecture

Jih-Hao Hung
Visiting Associate Professor
Department of Earth, Atmospheric, and Planetary Sciences

Alan Joslin
Visiting Associate Professor
Department of Architecture

Hasan Uddin Khan
Visiting Associate Professor
Department of Architecture

Aart Kraay
Visiting Associate Professor
Sloan School of Management

Stephen Machin
Visiting Associate Professor
Department of Economics

Eva Meyersson Milgrom
Visiting Associate Professor
Sloan School of Management

Hubert Murray
Visiting Associate Professor
Department of Architecture

Kenneth K. O
Visiting Associate Professor
Department of Electrical Engineering and Computer Science

Gordon Phillips
Visiting Associate Professor
Sloan School of Management

Daniel Richards
Visiting Associate Professor
Sloan School of Management

Octavio Richetta
Visiting Associate Professor
Sloan School of Management

Hans-Joachim Voth
Visiting Associate Professor
Department of Economics

Visiting Assistant Professor

Markus Brunnermeier
Visiting Assistant Professor
Sloan School of Management

Linda Bui
Visiting Assistant Professor
Department of Economics

W. E. Douglas Creed
Visiting Assistant Professor
Sloan School of Management

Scott A. Hughes
Visiting Assistant Professor
Department of Physics

Valeria Koukoutsi-Mazarakis
Visiting Assistant Professor
Department of Architecture

Kwang Hui Lim
Visiting Assistant Professor
Sloan School of Management

Juan-Pablo Montero
Visiting Assistant Professor
Sloan School of Management

Austin Parsons
Visiting Assistant Professor
Department of Architecture

Sean T. Paul
Visiting Assistant Professor
Department of Mathematics

Attilio Rigotti
Visiting Assistant Professor
Department of Biology

Margaret Anne Storey
Visiting Assistant Professor
Department of Aeronautics and Astronautics

Susan Tolman
Visiting Assistant Professor
Department of Mathematics

Tan Wang
Visiting Assistant Professor
Sloan School of Management

Ezra W. Zuckerman Sivan
Visiting Assistant Professor
Sloan School of Management

Administrative

Deaths

Joseph D. Gibbs
Supervisor, Paint Shop
Department of Facilities

Trond Hans Kaalstad
Administrative Officer
Department of Civil and Environmental Engineering

Thomas J. Owens
Head, Library Systems Office
Libraries

Carol Ann Ramey
Administrative Assistant
Department of Earth, Atmospheric, and Planetary Sciences

Robert G. Stedman
Supervisor, Mechanical Services
Superintendent's Office

Charles O. Webber
Engineering Assistant
Department of Facilities

John M. Wynne
Vice President
Office of the Vice President

Retirements

Joseph E. Baclawski
Manager of Corporate Relations
Corporate Development

Mary J. Bacon
Purchasing Agent
Purchasing Field Office

Mary Barry
Student Account Counselor
Student Financial Services

Vincent P. Clark
Senior Project Manager, Construction
Department of Facilities

Virginia Esau
Administrative Officer
Department of Physics

Carl William Hagge, II
Coach, Repair And Maintenance
Department of Facilities

Noel P. Hart
Senior Systems Programmer
Information Systems

Karen Hersey
Senior Counsel for Intellectual Property
Intellectual Property Counsel

Robert E. Lee
Assistant Treasurer, Investment Administration
Treasurer's Office

Susan C. Lowance
Executive Director of Executive Education
Sloan School of Management

Thomas M. Lynch
Technologist
Environmental Health and Safety

Robert L. Malster
Manager of Corporate Relations
Corporate Development

Patricia A. McCosco
Administrative Officer
Department of Mechanical Engineering

J. Terence Meehan
Director
Property Office

Anthony Rogers
Director of Operations
Medical Department

Charles R. Studebaker
Chief Engineer, Central Utilities Plant
Department of Facilities

Betty H. Sultan
Administrative Staff
Dean for Student Life

Janet (Sally) M. Wright
Manager, Outpatient Administrative Services
Medical Department

Resignations

David B. Achenbach
Manager, Labor Relations
Human Resources

Yezmin Acle
Admissions Counselor
Admissions Office

Daniela A. Aivazian
Organizational Planning Consultant
Information Systems

Jessica L. Allen
Administrative Staff
Technology Review

Danilo D. Almeida
Systems Programmer
Information Systems

Rachael Astyk
IT Consultant
Financial Systems Services

Gina R. Baral
Health Educator for Students
Medical Department

Paul J. Baratta
Lieutenant
Campus Police

Amy E. Barone Phillips
Research Analyst
MIT Press

Margaret S. Benson
Financial Analyst
Department of Facilities

Phillip M. Bernard
Manager, Undergraduate Residential Services
Student Life Programs

Ricardo Bianco
Career Development Counselor
Career Services and Preprofessional Advising

Siobhain Blank
House Manager
Department of Housing

Karen R. Blum
Senior Major Gifts Officer
Office of Campaign Giving

Christine M. Boisvert
Area Supervisor, Animal Resources
Division of Comparative Medicine

Sharon A. Bradshaw
Financial Analyst
Sloan School of Management

Heather M. Buch
Analyst Programmer
Information Systems

Jessica S. Busiek
Alumni Affairs Officer
Alumni Association

John M. Caronna
Director of Advertising Sales
Technology Review

Eric F. Celeste
Assistant Director for Technology Planning and Administration
Libraries

Carolyn Chamberlin
Director of New Business Development
Technology Review

Judith P. W. Clark
Senior Research Analyst, Resource Development
Office of Development Research and Systems

Rocklyn E. Clarke
Senior Project Manager
Information Systems

Jean-Michel G. Claus
Analyst Programmer
Department of Mathematics

Stacie J. Clayton
Donor Relations Associate
Communications/Resource Development

Robert A. Clifford
Officer
Environmental Medical Service

Janet M. Connors
Legal Assistant
Environmental Program and Risk Management and Senior Counsel

Marybeth Costa
Financial Officer
Department of Physics

Thomas P. Culhane
Chief Financial Officer
Credit Union

Todd W. Date
Officer
Environmental Medical Service

Marcy Dill
Administrative Staff
Technology Review

George E. Dow, Jr.
Chief Information Officer
Credit Union

Matthew M. Dugan
Business Systems Analyst
Financial Systems Services

Kerry E. Enright
Alumni Affairs Officer
Alumni Association

Tamara M. Ewing
Gift Planning Coordinator
Office of the Vice President of Resource Development

Craig M. Fennell
Associate Director
Student Financial Services

Janet Fisher
Associate Director, Journals
MIT Press

Teresa Flannery
Alumni Affairs Officer
Alumni Association

Robina E. Folland
Administrative Officer
Harvard-MIT Division of Health Sciences and Technology

Abigail J. Fox
Senior IT Consultant
Information Systems

Steven T. Gottlieb
Senior Research Analyst, Resource Development
Corporate Development

Lori E. Grace
Financial Staff Assistant
Center for Real Estate

Sara R. Gregg
Journals Editorial and Production Manager
MIT Press

Julian M. Gustasson
Systems Programmer
Information Systems

Donald L. Haes, Jr.
Officer
Environmental Medical Service

Millene Hahm
Assistant Director of Admissions
Admissions Office

Diana J. Haladay
OED Consultant
Human Resources

Beatrix A. Henize
Industrial Liaison Officer
Corporate Relations/Industrial Liaison Program

Sarah J. Hernandez
Student Account Counselor
Student Financial Services

Maura Herson
Associate Director of MBA Student Affairs
Sloan School of Management

Loriann S. K. Higashi
IT Consultant
Information Systems

William E. Irwin
Officer
Environmental Medical Service

Thomas R. Ittelson
Technology Licensing Officer
Technology Licensing Office

Mark A. Janssen
IT Consultant
Information Systems

Ryan A. Jimenez
Public Relations and Marketing Coordinator
Museum

Wayne W. Jones
Associate Head Librarian
Libraries

Michael C. Killeen
Supervisor/Coach, Mail Services
Department of Facilities

Catherine E. Kim
Assistant Sales Manager
Sloan School of Management

Timothy C. King
Chief Financial Officer
Credit Union

John D. Kramer
Broker, Publishing Design Specialist
Public Relations Services

Katerina Lalioti
Senior Analyst Programmer
Financial Systems Services

Sirijit Lertkhachonsuk
Advisor, International Students
Graduate Students Office

Paul A. Lingard
Administrative Staff
Alumni Association

Robert D. Loomis
Technical Supervisor
Office of Development Research and Systems

Norma Lopez
Program Coordinator for Student Activities
Student Life Programs

William P. Lynch
Area Supervisor, Animal Resources
Division of Comparative Medicine

Susan S. Maynard
Alumni Affairs Officer
Alumni Association

William H. McCormick
Assistant Production Manager
MIT Press

Jeffrey P. McGillicuddy
Administrative Staff
Technology Review

Dan Milstein
Senior Systems Programmer
Alumni Association

Dennis P. Nations
Director, Benefits
Human Resources

Susan C. Negro
Human Resources Officer
Alumni Association

Tamaan K. Osbourne-Roberts
Assistant Director
Admissions Office

Claire E. Oshetsky
Senior Writer
Technology Review

Michele Papile
Network Administrator
Treasurer's Office

Charles A. Perry, Jr.
Sergeant
Campus Police

Susan A. Petrie
Publisher, SMR
Sloan School of Management

Jane Pickering
Director
Museum

Christopher D. Pisano
Administrative Staff
Technology Review

Daniel J. Pope
Senior Technical Writer
Financial Systems Services

Christopher G. L. Pratt
Director, Career Services and Preprofessional Advising
Office of the Dean for Undergraduate Education

Joan J. Preble
Administrative Assistant
Office of the Vice President of Resource Development

Randall D. Preston
Senior Project Manager
Department of Facilities

David F. Rapp
Research Analyst
Technology Review

Laura Reiner
Librarian
Libraries

Elise D. Renoni
Administrative Assistant
Office of the Provost

Catherine E. Riordan
Network Administrator
Department of Linguistics and Philosophy

Kathleen A. Romeo
House Manager
Department of Housing

Lisa M. Rung
Assistant Registrar
Registrar's Office

Kori M. Sahin
Assistant Director
Career Services and Preprofessional Advising

Steven M. Schaefer
Associate Director
Office of Foundation Relations

Andrew H. Sexton
Operations and Financial Administrator
Office of the President

Sharon S. Shamir
Assistant Health Educator
Medical Department

Sarah L. Shreeves
Project Manager
Libraries

Megan G. Sniffin-Marinoff
Head Librarian
Libraries

Cynthia E. Souza
Space Information Officer
Department of Facilities

Pamela Jo Spencer
Assistant Director, Masters Program
Sloan School of Management

Jessica D. Stanton
Associate Director, Resource Development
Sloan School of Management

Virginia Steel
Associate Director
Libraries

Janice C. Thompson
Associate Director
Campaign Giving

Jennifer Toli
Associate Director, Special Events
Sloan School of Management

Santina M. Tonelli
Student Administrator
Department of Political Science

Christopher S. Tresco
Systems Analyst
Department of Economics

Angela Suh Um
Director, Educational Council and Associate Director of Admissions
Admissions Office

Craig M. Venezia
Coach, Repair and Maintenance
Department of Facilities

Lisa M. Walsh
Operations Coordinator
Student Life Programs

Robert W. Whalen
Business Manager
Endicott House

Jean M. Wilcox
Assistant Design Manager
MIT Press

John S. Wilson
Director, Foundation Relations and School Development Services
Office of the Vice President of Resource Development

Frank J. Zarrella
Coach, Repair and Maintenance
Department of Facilities

Thomas P. Zgambo
Ombudsperson
Office of the President

New Appointments

Timea Adrian
Designer
MIT Press

Theresa A. Allen
Business Analyst
Student Financial Services

William Anderson
Project Manager
Dean for Student Life

Margarita Ascencio
Assistant Director
Office of Minority Education

Michael A. Assad
Lieutenant
Campus Police

Barbara A. Baker
Associate Dean for Student Life Programs
Dean for Student Life

Kim R. Beamon
Assistant Dean/Assistant Director
Office of Minority Education

Mark Begley
Systems Analyst
Department of Economics

Carla A. Bengtson
House Manager
Department of Housing

Jay A. Benoit
Streaming Media Services Coordinator
Academic Media Production Services

Christopher Bergonzi
Editorial Director
Sloan School of Management

Bruce M. Bernstein
Director, Educational Council and Associate Director of Admissions
Admissions Office

Robert E. Berson
Senior Financial Analyst
Information Systems

Holly A. Bickle
Financial Analyst
Information Systems

Karen E. Bleicher
Construction Coordinator
Department of Facilities

Nina R. Bohn
Associate Director of Major Gifts
Sloan School of Management

Matthew Bouchard
Graphic Designer
Technology Review

Timothy Brennan
Senior Technical Writer
Information Systems

Robert P. Bright
Manager, Facilities Operations
Medical Department

Helen L. Broderick
Administrative Officer
Department of Ocean Engineering

Michael S. Broderick
Systems Programmer
Information Systems

Marine Brown
Senior Fiscal Officer
Academic Media Production Services

Lawrence R. Brutti
Operations Manager
Parking and Transportation Office

Laurie C. Bryce
IT Consultant
Human Resources

Kevin Burns
IT Consultant
Information Systems

Lily U. Burns
Staff Associate
Office of the President

Julie Cecil
Coordinator
Career Services and Preprofessional Advising

Miguel Chacon
IT Consultant
Information Systems

Elizabeth Chadis
Development Officer
Department of Physics

Lora P. Chamberlain
Coordinator, Freshman/Alumni Summer Intern Program
Career Services and Preprofessional Advising

Joseph Chung
Staff Accountant
Credit Union

Jean-Michel G. Claus
Analyst Programmer
Department of Mathematics

Peter W. Cohn
Librarian
Libraries

Christine L. Colburn
Advisor, International Students
Graduate Students Office

Kimberly Cole
Alumni Affairs Officer
Alumni Association

Jennifer L. Connell
Senior Staff Accountant
Controller's Accounting Office

Jennifer L. Cooper
Financial Aid Counselor
Student Financial Services

Marybeth J. Corcoran
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John V. Cormier
Auditor
Audit Division

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Lieutenant
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Director of Physical Education
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Web Developer
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OpenCourseWare

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Web Content Editor
Information Systems

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Financial Analyst
Treasurer's Office

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John Dennett
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Alumni Association

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Student Services Information Technology

Sarah Merrow
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Program in Writing and Humanistic Studies

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Heather A. Miller
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Consortium on Finance of Higher Education

Amitava Mitra
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Academic Media Production Services

Yoko Mizuno
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Kathleen Monagle
HR Specialist
Human Resources

Joseph Michael Monahan
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Kristen Morreale
HR Specialist
Human Resources

Antoinette Muller
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Technology Review

Sarah B. Muzzy
Journals Marketing Manager
MIT Press

Deirdre Neylon
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Medical Department

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Human Resources

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Program Coordinator for Student Activities
Student Life Programs

Martin O'Brien
Manager, Facilities Operations
Department of Facilities

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Network Administrator
Treasurer's Office

Martha Ondras
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Department of Facilities

Catherine M. Otis
Donor Relations Associate
Communications/Resource Development

Gabrielle Pardo
Residential Life Associate
Student Life Programs

Osung (Victor) Park
New Media Broker/Designer
Public Relations Services

Michael C. Parkin, Jr.
CAD/GIS Specialist
Department of Facilities

Signe C. Pereira
Coordinator, Educational Services
Museum

Leigh R. Perry
Events Coordinator
Communications/Resource Development

Albert F. Pierce, Jr.
Lieutenant
Campus Police

Marianna C. Pierce
Manager, Labor Relations
Human Resources

Aaradhana Prajapati
Residential Life Associate
Student Life Programs

Emily A. Ranken
Officer
Environmental Health and Safety

Greg J. Raposa
Facilities and Operations Administrator
Libraries

Jeffrey L. Reed
Web Services Consultant
Information Systems

Jonathan D. Reed
Athena-RCC Consultant
Information Systems

Mary Reilly
Electronic Manuscript/Art Coordinator
MIT Press

Christopher Resto
Administrative Director, UPOP
School of Engineering - UPOP

Bernard J. Richard
Manager, Repair and Maintenance
Department of Facilities

Hans J. Richter
Officer
Environmental Health and Safety

John R. Rivers
Senior Project Manager, Construction
Department of Facilities

Amanda Romero
Student Account Counselor
Student Financial Services

Janet E. Rossi
Senior Production Coordinator
MIT Press

Gregory Roulette
IT Consultant
Information Systems

Wade E. Roush
Senior Writer
Technology Review

Molly E. Russell
Assistant Director
Office of School Development Services

Kristin A. Ryan
Contract Administrator
Office of Sponsored Programs

Gary Saffie
Coach, Repair and Maintenance
Department of Facilities

Kurt D. Samuelson
Senior Project Manager, Construction
Department of Facilities

Marsha Sanders
Senior Communications Officer
Office of the Provost

Lydia Schroter
Manager, Investment Administration
Treasurer's Office

Eleonora D. Serotek
Administrative Officer
Department of Chemistry

Paul D. Shay
Events Coordinator
Audio Visual Services

Daniel E. Sheehan
Financial Officer
Department of Physics

Maria Shkolnik
Staff Associate
Office of Academic Services

Jason K. Shumaker
Staff Associate
Office of the Dean for Undergraduate Education

Michael L. Silver
Senior Industrial Liaison Officer
Corporate Relations/Industrial Liaison Program

Cynthia H. Skier
Alumni Affairs Officer
Alumni Association

Mackenzie Smith
Associate Director
Libraries

Joycelyn J. Snell
Senior Associate Director, Career Education and Counseling
Sloan School of Management

Carter McCready Snowden
Faculty Liaison, Academic Computing
Information Systems

Rita Geller Snyder
HR Specialist
Human Resources

Curtis Soo Hoo, Jr.
House Manager
Department of Housing

Garikipati Sreelakshmi
Analyst Programmer
Financial Systems Services

Nicole V. Stark
Coordinator, Engineering Special Programs
School of Engineering

Susan Starr
Analyst Programmer
Information Systems

Robert Stiles
Coach, Repair and Maintenance
Department of Facilities

Jennifer K. Stine
Administrative Staff
School of Engineering

Laura Stuart
Health Educator for Students
Medical Department

Giri Swaminathan
Analyst Programmer
Information Systems

Kelli A. Talbot
Executive Assistant to the CEO
Technology Review

Augusta Thomas
Analyst Programmer
Department of Facilities

Carmen J. Tirado
Branch Manager
Credit Union

Anne O. Toal
Internet Sales Account Manager
Technology Review

Christina A. Toro
Senior Major Gifts Officer
Office of Campaign Giving

Daniel Trujillo
Associate Dean for Alcohol Education and Policy
Dean for Student Life

Elizabeth P. Tuff
Research Analyst
Corporate Relations/Industrial Liaison Program

Loren E. Van Allen
Associate Director, Resource Development
Sloan School of Management

Laurie E. Veal
Assistant Chief Project Manager
Environmental Program and Risk Management and Senior Counsel

Lynne M. Vellante
Associate Director, Geographic Programs
Sloan School of Management

Jonathan Jacob Venezian
Analyst Programmer
Information Systems

Grace H. Wang
Admissions Counselor
Admissions Office

Jonathan D. Ward
Broadband Technical Consultant
Information Systems

Ann E. Warner
Human Resources Officer
Technology Review

Maryann Wattendorf
Manager, Marketing and Market Research
Medical Department

Ellen Weiss
Assistant Manager
Human Resources

Constance Welch
Supervisor, Quick Copy Center
Copy Technology Centers

John C. Welch
Information System Manager
Campus Police

Gordon K. White
Administrative Staff
Sloan School of Management

Jerry M. Whitlock
Associate Director
Student Financial Services

Sarah Q. Wicki
Curator
School of Architecture a nd Planning

Sheryl Wilhite
Librarian
Libraries

Sarah E. Williams
GIS and Statistics Specialist
Libraries

Karl Witt
IT Consultant
Information Systems

Susan M. Wolfe
Associate Director, Financial Services
Sloan School of Management

Susie Won
Manager of Federal Cost Studies
Office of Sponsored Programs

Caitlin E. Wright
Legal Assistant
Environmental Program and Risk Management and Senior Counsel

Greg W. Wymer
Project Coordinator, MIT Enterprise Forum, Inc.
Alumni Association

Karen Yegian
Administrative Officer
Department of Urban Studies and Planning

Christie F. Yih
Coordinator, Educational Services
Sloan School of Management

Karen Young-Waithe
Assistant Director of Admissions
Admissions Office

Bin Zhou
Analyst Programmer
Student Services Information Technology

Changes of Appointments

Irene T. Abrams
Technology Licensing Officer
Technology Licensing Office

Peter D. Bedrosian
Classroom Facilities Manager
Registrar's Office

Andrew M. Boardman
Senior Systems Programmer
Information Systems

Rui Borges
House Manager
Residential Life

Maria Brennan
Assistant Director, International Students Office
Graduate Students Office

Matthew S. Brody
Senior Project Manager
Information Systems

Stephanie Bromander
Purchasing Agent
Controller's Accounting Office

Robert B. H. Buderi
Editor
Technology Review

Veronika D. Bulkin
Alumni Affairs Officer
Alumni Association

Richard F. Cahaly, Jr.
Legal Assistant
Intellectual Property Counsel

Jean G. Caloggero
Publishing Procurement Specialist and Assistant to the Director, PSB
Public Relations Services

David B. Camacho
Senior Research Analyst, Resource Development
Corporate Development

Mary S. Camerlengo
Staff Associate, DUE
Office of Academic Services

Kathryn V. Carty
Chief Information Officer
Credit Union

Francis D. Cassidy
Technology Licensing Officer
Technology Licensing Office

Lora P. Chamberlain
Assistant Director, UPOP
School of Engineering - UPOP

Cynthia L. Chomka
Alumni Affairs Officer
Alumni Association

Jo-Anne M. Chute
Property Manager
Property Office

Margaret E. Chute
Manager, Organization and Employee Development
Human Resources

Debra E. Cobb
Senior Accounting Officer
Treasurer's Office

Andrea M. Collins
Analyst Programmer
Student Services Information Technology

William H. Connelly, Jr.
Auditor
Audit Division

Craig A. Counterman
Senior IT Consultant
Information Systems

Lynn E. Couturier
Director of Physical Education
Athletic Department

Michael J. Croughwell
Property Administrator
Lincoln Fiscal Office

John G. Cunningham
Project Manager
Financial Systems Services

Mark J. Damian
Project Manager
Financial Systems Services

Anthony Davis
Assistant Director IT Administration
Department of Housing

Bette K. Davis
Director, HASS Office
School of Humanities, Arts and Social Science

William DeOliveira
Property Auditor
Property Office

Louis Diberardinis
Director
Environmental Health and Safety

John E. Driscoll
Deputy Chief
Campus Police

Regina Dugan
Insurance Manager
Controller's Accounting Office

John P. Dunbar
Assistant To the Provost for Space Planning
Office of the Provost

Ellen F. Duranceau
Librarian
Libraries

John E. Dvorak
Audit Supervisor
Audit Division

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Assistant Accounting Officer
Controller's Accounting Office

Monica L. Ellis
Director, Class Programs
Alumni Association

Alexandra Ellwood
Systems Programmer
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Barbara J. Engel
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Whitaker College of Health Science and Technology

Talitha Fabricius
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Director of Finance
Office of the Executive Vice President

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Career Services and Preprofessional Advising

John J. Fothergill, Jr.
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Information Systems

Anna Frazer
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Office of the Provost

Catherine A. Gamon
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Sloan School of Management

Richard Garcia
Senior IT Consultant
Information Systems

Elizabeth A. Garvin
Managing Director
Alumni Association

Steven Gass
Associate Director
Libraries

Virginia Gifford Reckley
Information System Manager
Sloan School of Management

Yvonne L. Gittens
Assistant Director
Student Financial Services

Barrie B. Gleason
Director, Communications Office
Graduate Students Office

James Martin Gosser
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MIT Press

Jean E. Greene
IS Admininstrative Services Team Leader
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Danielle Guichard-Ashbrook
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Mary L. Hanifin
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School of Engineering

Rosemary B. Hegg
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Anthropology Program

Gail E. Nicole Hennig
Librarian
Libraries

Gail E. Nicole Hennig
Web Services Manager
Libraries

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MIT Press

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Technology Licensing Office

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Dean of Science

Elizabeth Karagianis
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Amy E. King
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James M. Kretchmar
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Technology Review

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Minerva Tirado
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Foreign Languages and Literatures Section

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